



The global status of seaweed production, trade and utilization

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The global status of seaweed production, trade and utilization

Volume 124

The global status of seaweed production, trade and utilization

by

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ABSTRACT

This report is an update of the status of the global seaweed market: production figures from culture and capture, the size of the international market for seaweed and its commercially important extracts, the leading nations by region, developments in processing and utilization technology, and innovations in the industry, as well as the challenges and outlook for the industry.

As it is not possible to feature all individual countries of importance in the seaweed sector, several have been selected as being representative of the different regions of the world: Asia [China, Indonesia, the Republic of Korea, Malaysia, the Philippines, Singapore and Thailand]; South America (Chile); Europe (Denmark, the European Union); and Africa (Morocco, South Africa and Zanzibar (Tanzania)]. The sections on Chile, China, Denmark and South Africa are based largely on previous studies commissioned by the Food and Agriculture Organization (FAO).

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1. OVERVIEW

1.1 INTRODUCTION

Seaweed, or marine algae, comes in various shades of red, brown and green, and may be shaped in the form of broad leaves, delicate fingers, spheres or may resemble fruit. Although a few genera are free-floating, most are anchored in littoral zones. Some tuft-forming, blue-green algae (*Cyanobacteria*), at times, may be considered seaweed.

Seaweed has been utilized throughout the world for centuries, and was considered only as a food source for coastal communities in the earliest times. Apart from its wide-ranging use in many industries (as will be elaborated upon later), seaweed contributes greatly to the nutritional status of communities due to its rich composition of macronutrients such as sodium, calcium, magnesium, potassium, chlorine, sulphur and phosphorus; micronutrients (iodine, iron, zinc, copper, selenium, molybdenum, fluoride, manganese, boron, nickel and cobalt); and vitamins (B12, A, K). In taking iodine, for example, the daily adult requirement of 150 µg/day is easily met by small quantities of seaweed, particularly brown algae such as kelp, which has an iodine content that ranges from 1 500–8 000 parts per million. According to the World Health Organization, iodine deficiency is the most prevalent and easily preventable cause in the world of impaired cognitive development in children.

Some 221 species of seaweed are of commercial value. About ten species are intensively cultivated, such as brown seaweed (*Saccharina japonica*, *Undaria pinnatifid* and *Sargassum fusiforme*); red seaweed (*Porphyra* spp., *Eucheuma* spp., *Kappaphycus alvarezii* and *Gracilaria* spp.); and green seaweed (*Enteromorpha clathrata*, *Monostroma nitidum* and *Caulerpa* spp.). Japanese kelp (*Saccharina japonica*, formerly classified as *Laminaria japonica*) accounts for over 33 percent of global cultivated seaweed production, followed by *Eucheuma* spp. at 17 percent of total *Kappaphycus alvarezii* (Elkhorn sea moss), *Undaria pinnatifida* (Japanese wakame) and *Porphyra* spp. (Japanese nori). Microalgae (*Spirulina* spp.) also is cultivated, although it tends to be much under-reported; hence, the reported statistics are a small proportion of existing production. Australia, India, Israel, Japan, Malaysia and Myanmar are known producers of *Spirulina*.

Red seaweed, such as *Gelidium*, *Gracilaria* and *Pterocladis*, are important for human consumption and other uses, mainly as a binder in food products as well as a bacterial substrate in laboratories. *Eucheuma* and *Kappaphycus* are essential for the manufacture of carrageenan, used in cosmetics, food processing and industrial usage.

Brown seaweed (*Saccharina japonica* (Japanese kombu), *Undaria pinnatifid* (Japanese wakame), and *Sargassum fusiforme* (Japanese hiziki)) and green species (*Ulva* sp., *Enteromorpha* sp., *Monostroma* sp., *Caulerpa* sp. and *Codium* sp.) are important food resources in Asia, and are most commonly eaten raw, dried or boiled in soups and stews. They are considered to be a good source of food fibre, protein and minerals for human consumption.

Today, the global seaweed industry is worth more than USD 6 billion per annum (approximately 12 million tonnes per annum in volume) of which some 85 percent

comprises food products for human consumption. Seaweed-derived extracts (carrageenan, agar and alginates) make up almost 40 percent of the world's hydrocolloid market in terms of foods; the rest come from certain animals, microbes and land plants.

The most important extract, carrageenan, is named after the red seaweed, 'carrageen moss/Irish moss', found in Carraigin, Ireland, which has been used as a gelatin as well as for traditional healing for more than 1 000 years. Carrageenan is used in the pet food, dairy and meat industries and, to a lesser extent, the pharmaceutical industry. There are three main types of carrageenan: kappa, iota and lambda, which come mainly from *E.cotonii*, *E. spinosum* and *Chondrus crispus*, respectively. Kappa carrageenan is widely used in food additives and produces strong rigid gels; iota carrageenan are more elastic and soft; and lambda carrageenan provides the creamy sensation in dairy products. The carrageenan concentration is usually from 0.005 percent to 2 percent by weight in food products.

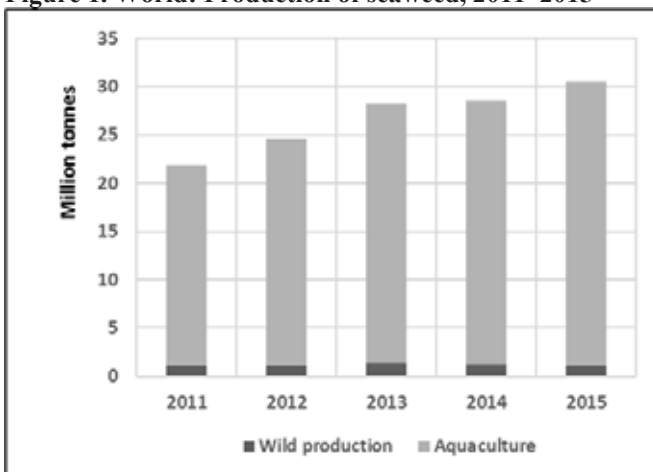
Agar, or agar agar, has had a strong demand in most Asian countries as a foodstuff since more than 300 years ago, and alginates have been used in the textile printing industry since approximately 1020. Agar agar is mainly produced from the *Gracilaria* seaweed, with China as the world leader with a reported harvest of 2.7 million tonnes of farmed *Gracilaria* in 2015. Though domestic consumption is high, China's share in the international trade of alginates is also significant, including for agar agar. Currently, Chile and China are the largest producers and exporters of agar agar. Supplies to the international trade also have increased from Indonesia, Morocco and Thailand in response to rising global demand.

1.2 GLOBAL PRODUCTION OF SEAWEED

In 2005, world seaweed production totalled 14.7 million tonnes, of which the culture sector contributed 13.5 million tonnes (freshwater culture: 53 157 tonnes; brackishwater culture: 46 729 tonnes; and marine culture: 13.4 million tonnes), while the harvest from the wild was slightly over 1.2 million tonnes in the same year. Ten years later, by 2015, the total production had doubled to 30.4 million tonnes, with the culture and capture sectors responsible for 29.4 million tonnes and 1.1 million tonnes, respectively (Figure 1).

The leading producers by country (in order of decreasing rank) were Chile, China and Norway for wild species (mainly brown and red) and Chilean kelp; and China, Indonesia, the Republic of Korea and the Philippines for cultured species (mainly *Eucheuma*, Japanese kelp, *Gracilaria* and *Undaria pinnatifid*). The detailed global production data for the capture and culture sectors, by country and species (Q = tonnes; V = USD '000) are appended in Annexes 1–6.

Figure 1. World: Production of seaweed, 2011–2015



Source: FAO.

1.2.1 Harvested from the wild

In contrast to the farming sector, wild harvests have remained almost level from approximately 1.06 million tonnes in 2006 to a peak of 1.29 million tonnes in 2013, and settling at about 1.09 million tonnes (wet weight) in 2015, according to FAO statistics (Annex 1). The top four producers of wild seaweed in 2015 were Chile (345 704 tonnes), followed by China (261 770 tonnes), Norway (147 391 tonnes) and Japan (93 300 tonnes) (Annex 2).

The dominant species harvested from the wild are Chilean kelp (*Lessonia nigrescens*) at 22 percent of the harvested total, followed by *huiro palo* (*Lessonia trabeculata*) at 7 percent, *Gracilaria* spp. at 5 percent and the rest – tangle (*Laminaria digitata*), *luga negra* (*Sarcothalia crispata*), kelp (*Macrocystis* spp.), Japanese kelp (*Saccharina japonica*), North Atlantic rockweed (*Ascophyllum nodosum*) and *Gigartina skottsbergii* – accounting for less than 5 percent. Farmed and wild *Gracilaria* species are a major source of agar agar for human consumption.

A significant issue with wild seaweed is the possibility of contamination by heavy metals such as arsenic and mercury. These act as a restraint on market expansion, especially in countries which place a high premium on food safety and sustainability. Consumers will be more willing to pay for seaweed that originates from countries with a strictly enforced integrated coastal zone management policy.

1.2.2 Farmed seaweeds

The most important farmed seaweed species is *Eucheuma* (10.2 million tonnes in 2015), followed by Japanese kelp (8 million tonnes), *Gracilaria* spp. (3.9 million tonnes), *Undaria pinnatifid* (Japanese *wakame*) (2.3 million tonnes), *Kappaphycus* (1.8 million tonnes), and *Porphyra* spp. (Japanese *nori*) (1.2 million tonnes). The

production volumes of other seaweed species fall below the one-million-tonne mark (Annex 3).

Seaweed cultivation takes place in about 50 countries, with the top ten producers in value being (in descending order) China, Indonesia, Japan, the Republic of Korea, the Philippines, the Democratic People's Republic of Korea, Malaysia, Chile, Sri Lanka and Madagascar (Annex 4). In volume terms, the ranking changes (in descending order) to China, Indonesia, the Philippines, the Republic of Korea, the Democratic People's Republic of Korea, Japan, Malaysia, Zanzibar, Madagascar and the Solomon Islands (Annex 5). While Chinese output accounts for approximately 60 percent of the global volume, Japan ranks third in value due to its production of *nori*. Globally, *Undaria pinnatifid* (Japanese *wakame*) and *Gracilaria* seaweed are the two other highly valued seaweed species (Annex 6). Annexes 4 and 5 clearly indicate that countries in East Asia and Southeast Asia contribute the major share of the world's farmed seaweed in terms of volume and value.

In Southeast Asia, seaweed is widely cultivated in response to rising demand for its use, primarily as raw material for the hydrocolloid industry (agar agar, alginate and carrageenan extracts). This industry is estimated to be growing at 2–3 percent per annum, mainly in the Asia and the Pacific region. Outside of Asia, cultured seaweed is exported mainly from Madagascar and Zanzibar (Tanzania) in Africa and Chile in South America.



Nori is a staple in Japanese cuisine.
© FAO/Fatima Ferdouse

A major advantage in the cultivation of seaweed is the fact that feeds, the cost and availability of which are often limiting factors in the aquaculture of fish and fishery species, are generally not needed in this regard. It also does not require elaborate setups and causes little harm to the seabed and fishery resources. Consequently, it is often promoted in developing countries as a sustainable activity that is capable of providing alternative livelihoods for small-scale fishing communities. In some countries, seaweed culture is integrated with intensive fish farming, functioning as nursery grounds for fingerlings. Meanwhile, researchers are moving towards finding greener techniques in cultivation and utilization, as well as towards promoting the genetic diversity of seaweed stocks. The latter point is especially important in preventing large-scale losses due to

disease, as has occurred in the case of genetically identical seaweed stocks in the Philippines during the 2011–2013 period.

In many parts of the world, seaweed is grown together with fish and fishery species, although it often tends to be because the seaweed happens to grow in the vicinity compared to its planned presence in integrated multi-trophic aquaculture (IMTA) systems. Leading exceptions in Asia are China and the Republic of Korea where IMTA (not limited to seaweed) has been practised for many years.

In a report compiled by the United Nations University (UNU) in 2016, it was reported that in China's Sungo Bay (Shandong Peninsula), these culture systems – based on the integrated culture of kelp (*Saccharina japonica*), abalone and sea cucumber – have been in existence for more than two decades. Interestingly, the abalone feed on the kelp and generate organic waste which, together with uneaten feeds, is eaten by the sea cucumbers. The waste products from the sea cucumbers and abalone are then assimilated by the kelp which increases its own productivity. The kelp, in turn, is used as food by the abalone or may be harvested for human consumption. In Sansha Bay (Fujian Province), the culture system includes fish, abalone, oyster and seaweed. In Zhejiang Province, the co-cultured seaweed species are *Saccharina japonica*, *P. haitanensis*, *Gracilaria* spp. and *Sargassum* spp., and the total seaweed production each year is approximately 60 000 tonnes.

In Brazil, culturing seaweed within shrimp cages has resulted in improved economic returns for both species; in Chile, with *Gracilaria* and salmon farms, the seaweed has grown well and has removed a large amount of the ammonium excreted by the fish. In France, *Gracilaria* growing in the effluents from oyster farms has removed almost all the ammonia in the water. *Porphyra* spp. and salmon farming trials have taken place off the east coast of Canada and the United States of America.

1.3 SAFEGUARDING THE INDUSTRY

Within the context of a global boom in seaweed production and processing, a 2016 policy brief of the UNU called for stricter policies to ensure the sustainability of the industry. Pointing to the “unabated exponential growth in the last 50 years”, the UNU stated that “There is increasing need to address new challenges imposed by trade and market demand. Case studies clearly show that valuable lessons can be drawn from the major seaweed-producing nations and other aqua and agriculture sectors.” (Cottier-Cook *et al.*, 2016).

Some of the issues that the UNU has highlighted are the need to have efficient resource management in coastal areas, establish disease-free seed banks to reduce over-reliance on limited genetic stocks; and poor biosecurity guidelines that may allow the introduction of non-indigenous pests and pathogens into culture areas. Displacement of wild stocks due to competition with farmed seaweed and potential conflict with other users in the same area are also among issues identified.



Seaweed farmer in the Philippines regaining her livelihood after typhoon Haiyan.

© FAO

1.4 SOCIO-ECONOMIC BENEFITS FOR COASTAL COMMUNITIES

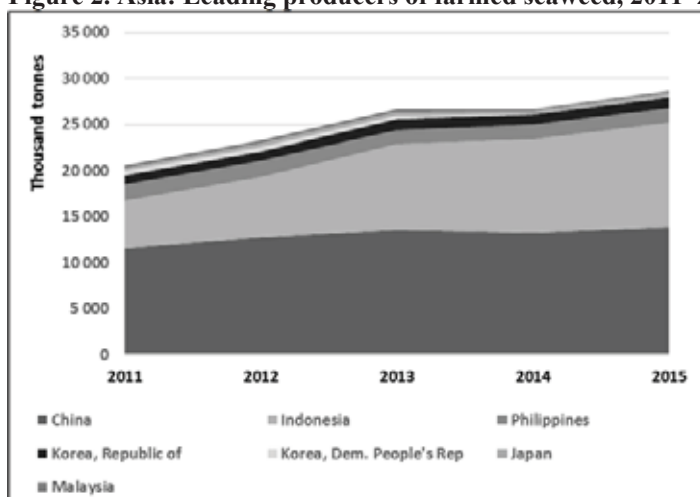
What makes seaweed harvesting from the wild and farming attractive to coastal communities is that the technology is relatively simple, requires low initial capital investment, the crop can be harvested in about six weeks and it can be dried on mats, grass, or on the beach sand. Furthermore, as the farming areas are in intertidal zones, women and children can safely access seaweed plots. These factors allow women, in particular, an important opportunity to earn some income for themselves and their families while the men work as fishermen and in other sectors. Several studies also have mentioned that women tend to be more patient and more willing to learn about sustainably managing local seaweed resources. This trend is seen in every region, particularly so in the Asia and the Pacific region (China, Indonesia, Malaysia, the Philippines) and Africa (Ghana, Morocco, Zanzibar (Tanzania)).

2. MAIN REGIONAL PRODUCERS AND MARKETS

2.1 ASIA

In Asia, China remains the largest producer, followed by Indonesia, Japan, the Democratic People's Republic of Korea, the Republic of Korea, Malaysia and the Philippines. The bulk of the production comes from the culture sector (Figure 2).

Figure 2. Asia: Leading producers of farmed seaweed, 2011–2015



Source: FAO.

Japanese farms along the coastal areas are able to provide more than 90 percent of the demand for *Porphyra* spp., *Saccharina japonica* and *Undaria* spp locally called *nori*, *kombu* and *wakame*, respectively. *Nori* is used for making sushi, *kombu* is generally used as seasoning in bean curd soups and *wakame* (slightly more upmarket than *kombu*) is used for bean curd soups and salads. At the same time, Japan is a leading importer of raw seaweed, with much of its supply coming from the Republic of Korea. A significant portion is processed into such products as agar, *nori* sheets and seasoned snacks which are consumed in the country and exported. Some 21 seaweed species are used daily in food preparation in Japan, with the average annual consumption per capita estimated at 4 kilograms (kg).

There is a large industry in Japan that is built around the agar, alginate, and carrageenan used in food products and other sectors. Alginate extraction is carried out using imported *Ecklonia* and *Durvillea antarctica*, and the material is then used for specific biotechnology applications. The carrageenan industry uses *Eucheuma* and *Kappaphycus* imported from Southeast Asian farms, as well as *Chondrus* and *Gigartina* wild stocks from the Americas and Europe.

Indonesia reported an output from 1.2 million tonnes in 2006 to 11.3 million tonnes in 2015 (Annex 5). The sector in that country has expanded at 8 percent per annum in the past decade, up from 6.2 percent in the previous decade, with output more than doubling in this period.

In Thailand, *Gracilaria* is the most commercially important species, followed by *Hypnea*, *Porphyra*, *Acanthophora* and *Caulerpa*. *Gracilaria* is used for human consumption and as a source of agar. Production is in limited volume (almost all wild harvests), resulting in imports of raw and processed products, generally *Porphyra* spp., *Saccharina japonica* and *Undaria* spp from China, Japan and the Republic of Korea. Of the imported products, food grade agar (from Chile, Japan, the Republic of Korea and Taiwan Province of China) ranks first in volume. In the Republic of Korea, brown species (*Saccharina japonica* and *Undaria* spp.) and red species (*Porphyra* spp.) make up almost all the country's seaweed production.

Gracilaria and to a smaller extent, *Sargassum*, are the two main seaweed species of importance in Viet Nam. Agar and alginates have a steady demand, and since the local farming and processing sectors are still developing, imports of *Gracilaria* are needed. Processing units for agar and sodium alginate have been established in Haiphong, Ho Chi Minh City and Danang. *Sargassum* is used as a fertilizer.

2.1.1 China

As mentioned in Section 1.2.2, Chinese output accounts for approximately 60 percent of the global volume of seaweed. Wild harvests make up less than 2 percent of this total volume, albeit production from aquaculture increased sharply from 9.7 million tonnes in 2006 to 13.9 million tonnes in 2015 (Annex 7). This indicates the absolutely vital role played by the culture sector.

Seaweed farming in China officially began in the 1950s, with the development of technology in the cultivation of kelp (*Saccharina japonica*); that is, new commercial varieties, including disease-resistant strains. From then on, the seaweed farming industry developed very fast and, by 2015, total seaweed production had escalated to nearly 14 million tonnes (Table 1).

Table 1. China: Farmed seaweed production, 2009–2015

	Weight in tonnes						
	2009	2010	2011	2012	2013	2014	2015
Brown seaweeds	5 543 485	5 587 550	5 994 165	6 758 500	6 941 315	9 011 595	9 170 515
Red seaweeds	2 395 370	2 285 030	2 602 840	3 191 070	3 692 680	3 806 890	3 910 290
Miscellaneous aquatic plants	2 546 300	3 208 390	2 943 250	2 873 390	2 922 860	506 630	842 530
Green seaweeds	10 750	11 300	9 300	9 100	4 590	1 200	1 200
Total	10 495 905	11 092 270	11 549 555	12 832 060	13 561 445	13 326 315	13 924 535

Source: FAO.

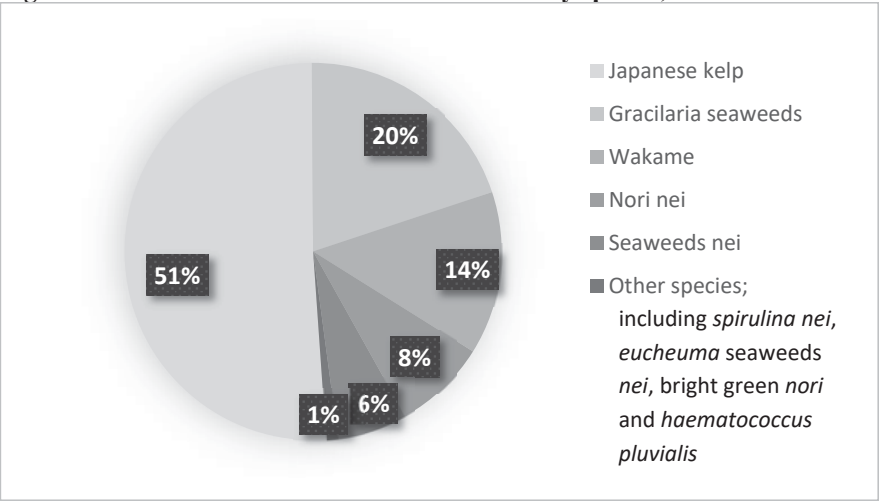
As shown in fishery statistics collected by FAO, China is the largest producer of cultivated algae around the globe. Estimated by protein content, the total production of China's eight species of farmed seaweeds in 2014 was equal to 3.0 million tonnes of rice,

10.54 million tonnes of spinach, 14.13 million tonnes of potato and 1.35 million tonnes of pork (Yang, 2016). Seaweed in China is measured in dry weight.

Main commercial seaweed species in China

Japanese kelp (*Saccharina japonica*) comprises close to 51 percent of the total amount of cultured seaweed; *Gracilaria* is in second place, followed by *Undaria* spp. (*wakame*) and *Porphyra* spp. (Japanese *nori*) (Figure 3). These four main species contributed 92 percent of total production in 2015 (Annex 7). *Saccharina japonica* is now the main commercial seaweed crop in China, with cultivation covering more than 40 000 per hectare and an annual production of approximately 1 million tonnes (dry weight). *Eucheuma* sp, *Hizikia fusiforme* and *Enteromorpha* sp are other major seaweeds in China.

Figure 3. China: Production of farmed seaweed by species, 2015



Source: FAO.

Three provinces (Fujian, Liaoning and Shandong) produced over 91 percent of total farmed seaweeds in 2014, particularly Fujian and Shandong provinces where the output is significant, at 40.56 percent and 33.06 percent, respectively (BFDA, 2015). Other provinces, including Jiangsu, Guangdong, Hainan and Zhejiang also produce some seaweed, but their production volumes are smaller than those of the three ‘giants’.

It also is worth mentioning, however, that the ranking of provinces in terms of farmed seaweed production is changing. For example, Shandong topped the list in 2002, followed by Liaoning and Fujian. By 2014, output from Fujian had increased by 147.28 percent from 2002, pushing it to first position. Shandong (though with a rise of 39.55 percent in the same period) fell to second place, with Liaoning (+6.98 percent) third.

For wild harvested seaweed, Hainan was the largest contributor from 2003 to 2014 (despite a general declining trend). The volume remains much smaller than farmed output.

Japanese kelp (*Saccharina japonica*)

Known also as sea tangle, Japanese kelp is known in China by its local name, *Hai Dai* (production volume in 2015: 7.06 million tonnes). It is served as a component in many food dishes and processed products. While it is found naturally only in the Liaodong and Shandong peninsulas, its main farming areas are along the coast from Liaoning to Guangdong province. Most of the *Saccharina japonica* produced in China is consumed as part of a ‘healthy vegetable’ diet. It is generally sold dried, although in recent years, small packages of seasoned seaweed have entered the snack food market. It is also important as a raw material for alginate, mannitol and iodine.

During the Three Kingdoms period, kelp was described as ‘sour, salty, cold, non-toxic, edible’, and as the ‘Therapeutic *Materia Medica*’ (written by Meng Shen in the Tang Dynasty) says, “kelps can help one to cure flatulence”. In addition, kelp is low in calories and is high in resin and minerals; it can be easily digested and absorbed.

Sea mustard (*Undaria pinnatifida*)

Natural populations of sea mustard in China are mainly distributed in Zhejiang province. In addition to natural reproduction, sea mustard is extensively farmed in the Dalian region and its products are mainly exported to Japan. Sea mustard is said to play an important role in the metabolism and development of the body, maintaining a balance of the cardiovascular, immune, blood and nervous systems.

Laver (*Porphyra* spp.)

There are as many as 134 sub-species of this seaweed, although only two of them are farmed: *Porphyra haitanensis* in the south of China (Fujian, Zhejiang and other locations) and *Porphyra yezoensis* in the northern provinces of China (Jiangsu, Shandong and other provinces).

Gracilaria sp

There are almost 100 kinds of *Gracilaria* that grow in a wide range of water temperatures in the South China Sea and East China Sea. It is the main feed ingredient for abalone and the key raw material for the extraction of agar. It has also been used in bioremediation to reduce eutrophication in mariculture areas.

Other species

Eucheuma is mainly found in the coastal areas of Hainan, Guangdong and Guangxi. Almost 90 percent of the global total yield of carrageenan is supplied by China, Indonesia and the Philippines.

Gelidium is served as a salad or processed into jelly. In addition to being edible, it is the main raw material for extracting agar, which is used to make cold foods or as a microbial culture medium. In addition, traditional Chinese doctors believe that *Gelidium* is sweet-salty and has a detoxification effect; thus it can be used for curing enteritis, anal

swelling, and pyelonephritis. It is also used as a folk medicine to cure silicosis, tinea corporis and thyromegaly.

Sargassum is widely distributed in Fujian, Liaoning, Shandong, Zhejiang and other coastal provinces, and is cultivated in Zhejiang province. As an antioxidant, *Sargassum* not only enhances the immune function and helps in the anti-aging and anti-inflammatory processes; it also inhibits tumour growth and reduces blood fat and sugar levels, among others.

Processing of seaweed

China's seaweed processing industry began in the 1960s, with one of the earliest ventures being the production of iodine, mannitol and alginate from kelp. China also has *spirulina* and green algae food processing industries, although the quantities are small. Some 50 years on, seaweed processing technologies have improved tremendously, with many seaweed processing enterprises having been established and the total output from the seaweed processing industry having escalated to approximately 1.08 million tonnes by 2014 (more than three times the volume in 2013). Almost 95 percent of the total processed seaweed products were from Fujian, Liaoning and Shandong provinces in 2014.

Japanese kelp



Instant sea tangle (brand: Guanwu Kelp).
© Yoycart

Processed Japanese kelp ranges from simple dried, salted items to more complex products such as food additives, beverages and other foods (e.g. seasoning and instant seaweed foods). Sometimes, it is added into traditional fermented items, resulting in products such as sea tangle soybean juice, lacto-fermented beverages with sea tangle flavour, sea tangle cakes, sea tangle milk, and sea tangle peanut jams.

There are more than 100 enterprises that process laver in China. In Fujian and Zhejiang, *Porphyra haitanensis* is the predominant laver that is farmed, from which dried laver is produced. In Jiangsu, with the introduction of equipment and technology from Japan, *Porphyra yezoensis* is the main species. It is processed principally into standard laver sheets and roasted laver.

Laver (*Porphyra spp.*)



Dried sea tangle.



Sea tangle knots.

Key processed laver products are as follows:

- (i) Dried laver and salted laver from preliminary processing, which involves cleaning, cutting, pressing, pickling, dewatering, drying and separating (usually by automated machines), followed by classifying, re-drying and packaging.
- (ii) Laver seasoning, laver sauce, laver drinks, laver puffed food, among others, from refined processing. The technology involved includes dehydration, freezing, expansion, slicing and seasoning, among others.
- (iii) Beverages, peptone, agar, concentrated juices, nutrients, among others, from deep processing. These items contain substances extracted from the laver.



Dried and pressed laver.
© Yang



Seasoned laver soup.
© Yang

Sargassum fusiforme

Currently, dried *Sargassum fusiforme* dominates China's domestic market. Because it is dried, it is convenient for storage, selling and transportation, and can help to balance the supply of *Sargassum fusiforme* throughout the year. The product is popular with consumers because it is convenient to use and has a unique taste. The processing technology is as follows: cleaning, cutting, hot pressing, removing arsenic and sand, seasoning, weighing and packaging, sterilizing, cooling and drying.

Sea mustard (*Undaria pinnatifida*) and other species



Dried *Undaria*.

© Yang

Dried and salted sea mustard are the main products in the domestic market. Similar to *Sargassum fusiforme*, it is an ‘instant’ food product and thus has good market potential.

Besides consumption as a food item, seaweed is commonly used in Chinese medicine. According to the *Oriental Materia Medica*, *Saccharina japonica* and *Ecklonia* (local name: *kunbu*), as well as *Sargassum* (*haizo*), enter the body through the liver, stomach and kidney, working to ‘soften hardness, disperse accumulation, resolve phlegm, and cleanse heat’, thereby helping persons with tumours, goitre, pains and swelling. *Porphyra* (*zicai*) enters the body through the lung, where it ‘resolves phlegm, softens hardness, dispels heat, promotes diuresis’, making it useful in cases of goitre, beriberi, oedema, urinary infections and sore throats.

Marketing and trade of seaweed and seaweed products

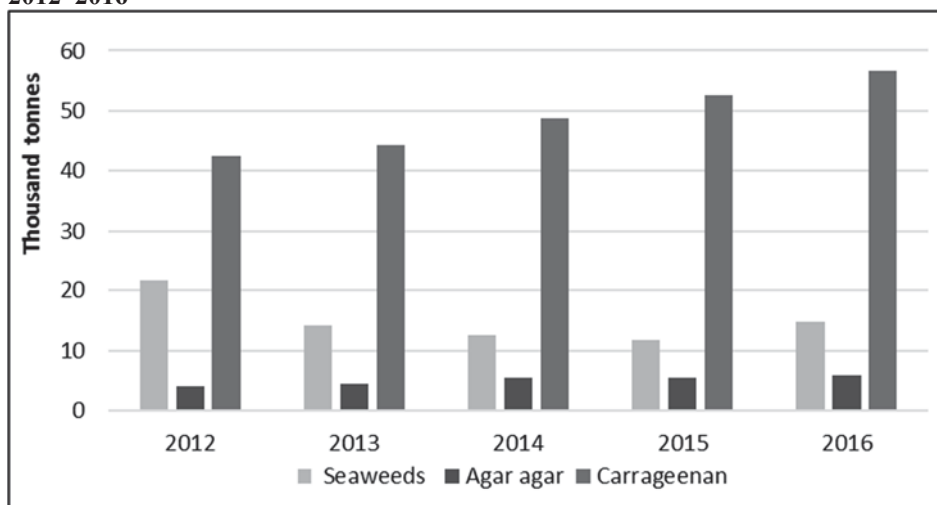
Exports

With regard to Chinese exports of seaweed and other algae fit for human consumption (Annex 8a), 14 721 tonnes was recorded in 2016 compared to 11 654 tonnes the previous year; however, this represented a drop from 21 595 tonnes in 2012. The top five markets (in descending order) for this category in the year 2016 were Japan (7 177 tonnes), Russia (1 861 tonnes), Portugal (1 187 tonnes), Taiwan Province of China (952 tonnes) and Spain (699 tonnes). Laver products, including flavoured laver and (the less expensive) dried laver, are one of the main export items. Besides Taiwan Province of China and the Hong Kong Special Administrative Region, the main target markets for laver exports are the Australia, Japan, Thailand and the United States of America. The flavoured laver is mainly exported to Australia, Thailand and the United States of America, while the dried laver is exported to Japan, Thailand and the United States of America.

Meanwhile, Chinese exports of the seaweed and other algae *not* fit for human consumption (Annex 8b) indicated a total of 1 477 tonnes in 2016 compared to 1 007 tonnes in 2012. The top five markets (in descending order) for this category in 2016 were Viet Nam (411 tonnes), the Republic of Korea (380 tonnes), the United States of America (272 tonnes) and Malaysia (252 tonnes).

Agar agar was also exported in appreciable quantities from China in 2016, with a total of 5 846 tonnes, valued at USD 86 024 million compared to 4 146 tonnes (USD 58 803 million) in 2012 (Figure 4). The leading markets were Italy (775 tonnes), Spain (663 tonnes), Malaysia (612 tonnes), Thailand (598 tonnes), Russia (569 tonnes), and Germany (521 tonnes) (Annex 8c). China has emerged as the world’s largest exporter of carrageenan, with nearly 60 000 tonnes of products in the international trade in 2016, valued at USD 360 million. The main markets were the European Union and the United States of America (Annex 8d and Annex 8e).

Figure 4. China: Exports of dried edible seaweed and other processed products, 2012–2016

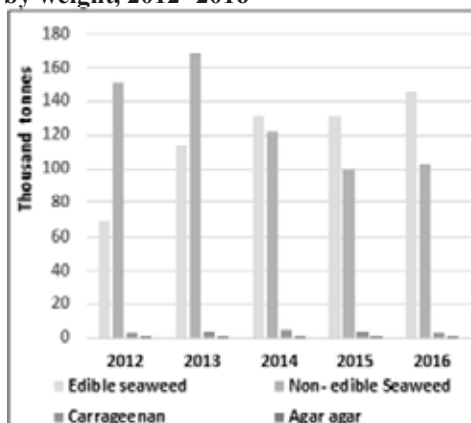


Source: China Customs.

Imports

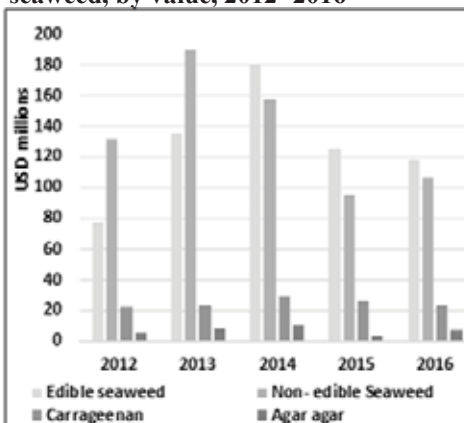
Chinese imports of seaweed and other algae in 2016 were 146 028 tonnes (USD 118 544 000) in the ‘fit for human consumption’ category (Annexes 9a, 17 and 18), slightly higher than 103 222 tonnes (USD 106 485 000) in the ‘not fit for human consumption’ category (Annex 9b). Noteworthy is the fact that only four years prior, in 2012, the figures were 68 812 tonnes (USD 77 271) and 151 209 tonnes (USD 131 937) for the two categories, respectively (Figure 5 and Figure 6). Imports of seaweed and algae for human consumption have clearly more than doubled within the space of four years; in contrast, there has been a small decline in the import of seaweed not for human consumption.

Figure 5. China: Imports of seaweed, by weight, 2012–2016



Source: China Customs.

Figure 6. China: Imports of seaweed, by value, 2012–2016



In 2016, seaweed and other algae for human consumption were imported (in descending order) mainly from Indonesia (137 450 tonnes), the Republic of Korea (3 266 tonnes), the Philippines (2 662 tonnes), Malaysia (1 279 tonnes) and Chile (921 tonnes) (Annex 9a). It should be noted that in 2012, Indonesia supplied 62 283 tonnes, marking an increase of 120 percent in the space of four years. Imports of agar agar by contrast, were much lower, with a total of 418 tonnes in 2016, supplied mostly by Italy (314 tonnes), with smaller amounts from the Republic of Korea and Morocco, among others (Annex 9c).

In summary, besides being the top seaweed producer in the world, China is a major exporter and importer of raw seaweed and seaweed products. In 2016, in the ‘fit for human consumption’ category, 14 721 tonnes were exported mainly to Australia, the Hong Kong Special Administrative Region, Japan, Taiwan Province of China, Thailand and the United States of America. Imports in the same year and in the same category, however, were much higher, at 146 028 tonnes originating from the Indonesia, the Republic of Korea Malaysia and the Philippines, among others. China, therefore, represents a huge (and still expanding) market for seaweed fit for human consumption, where it is eaten in soups, snacks, salads, as *nori* sheets and is manufactured into products such as seaweed noodles.

2.1.3 Indonesia

With more than 61 000 km of coastline spread over 17 000 islands, Indonesia has emerged as the second largest producer of cultured seaweed in the world following China. Of the global production of farmed aquatic plants (largely seaweeds) at around 29.4 million tonnes in 2015, recorded by FAO, Indonesia contributed almost 38 percent (11.3 million tonnes) compared to China’s 47 percent (14 million tonnes) (Table 2 and Annex 5).

Table 2. Indonesia: Seaweed production, 2010–2015

	Weight in tonnes					
	2010	2011	2012	2013	2014	2015
Aquaculture						
<i>Eucheuma</i> seaweeds <i>nei</i>	3 399 436	4 539 413	5 738 688	8 323 263	8 971 463	10 112 107
<i>Gracilaria</i> seaweeds	515 581	630 788	776 166	975 211	1 105 528.6	1 157 234
Total aquaculture	3 915 017	5 170 201	6 514 854	9 298 474	10 076 992	11 269 341
Wild production	2 697	5 479	7 641	17 136	70 514	78 230
Total	3 917 714	5 175 680	6 522 495	9 315 610	10 147 560	11 347 571

Source: FAO.

In contrast to China's production of seaweed and algae, primarily for human consumption, seaweed farming in Indonesia focuses on species such as *Eucheuma spp*, *Kappaphycus spp* and *Gracilaria spp* from which carrageenan and agar can be extracted. In recent years, demand for the food and non-food carrageenan quality, produced from *Eucheuma* and *Kappaphycus* seaweed, has increased rapidly in developed and developing markets alike worldwide. Indonesia is, in fact, the world's largest producer of these species. Farms are located mainly in Sulawesi, Maluku, West and East Nusa Tenggara, Northern Kalimantan and East Java.

Processing of seaweed extracts

The Indonesian hydrocolloid industry is relatively young, with most processing companies having been founded within the last 20 years. More than 30 seaweed processing companies engaged in producing semi-processed and processed seaweed (carrageenan and agar) are now active; however, according to industry estimates, the factory utilization for SRC production in Indonesia is 60–70 percent. They produce mainly SRC (food and non-food grades) and agar as well as RC. Other extracts include Alkali Treated Carrageenan, SRC and RC.

According to the Indonesian Seaweed Industry Association, the output of carrageenan products in 2013 totalled 12 500 tonnes (around 40 percent of total capacity), consisting of 1 720 tonnes of RC; 8 770 tonnes of SRC and 2 010 tonnes of Alkali Treated Carrageenan. Seven companies produce agar agar, while two companies produce food-based seaweed products with installed capacities of 6 240 tonnes/year and 480 tonnes/year, respectively according to the DG of Fishery Products Marketing and Processing, MMAF. Much of the technology has been imported and this has met with varying degrees of success. Most of these companies are in technical partnerships with overseas concerns, particularly Japanese corporate companies and trading houses. Some have successfully optimized their processes whereas others have struggled to bring their factories up to a good standard of operation.

Indonesia's current production of agar is estimated at over 12 000 tonnes, an increase from 8 000–9 000 tonnes produced during early 2002. Almost 60–70 percent of the production is diverted to the export market and the rest is consumed in the domestic food

market, although this ratio is likely to fluctuate in the future due to rising national incomes and greater domestic demand for agar agar.

Trade in raw and processed seaweed

Indonesia is the second largest producer of farmed seaweed. Domestic consumption is relatively low, and the bulk of exports consists of dried seaweed, particularly the edible varieties that are exported to Chile, China (85 percent), the Philippines and other Asian markets.

During 2012–2016, Indonesian exports of seaweed peaked in 2015 at 207 055 tonnes, valued at USD 170.3 million. There was a decline in 2016 to 183 257 tonnes, valued at USD 132 million (Table 3) due to lower exports to Chile, China and markets in the European Union in that year (Annex 10a). Exports of carrageenan, however, recovered during 2015 and 2016 (Figure 7 and Figure 8). The European Union, Japan and the United States of America are the top markets for carrageenan originating in Indonesia. Meanwhile, good domestic demand for agar agar has taken away the product from the export market in recent years.

Table 3. Indonesia: Exports of seaweed, 2012–2016

		2012	2013	2014	2015	2016
Seaweed & other algae, for human consumption	Tonnes	86 817	101 547	118 759	156 390	100 972
	USD thousands	62 631	89 904	136 450	127 361	70 195
Seaweed & other algae, <u>not</u> for human consumption	Tonnes	81 463	74 564	81 947	49 915	81 339
	USD thousands	71 524	72 552	89 778	33 048	53 818
Agar agar	Tonnes	1 292	1 056	933	750	946
	USD thousands	2 861	13 084	14 811	9 932	8 908
Carrageenan	Tonnes	5 266	5 299	4 933	5 190	5 503
	USD thousands	31 791	34 660	38 848	35 840	29 698
Total	Tonnes	169 572	177 167	201 635	207 055	183 257
	USD thousands	137 119	175 540	241 039	170 341	132 921

Source: Statistics Indonesia.

In 2015, 5 190 tonnes of carrageenan were exported, valued at nearly USD 30 million (Annexes 10b and 10c). The agar processing industry (mainly using *Gracilaria*) – although currently showing a lower output than carrageenan – is considered to have huge market potential, as the former has a strong foothold in the domestic market and is able to compete in the global market. Moreover, carrageenan companies are worried about the prospect of the delisting of carrageenan as an organic product in the U.S. market. The U.S. National Organic Standards Board has recommended to the United States Department of Agriculture that it delist carrageenan as an organic product; if this proceeds, carrageenan will no longer be qualified to be described as an organic product. Although the organic market share is relatively small, some food producers in the United

States of America have begun declaring their products as ‘carrageenan-free’, regardless of whether the product is organic or not.

Figure 7. Indonesia: Exports of seaweed, by weight, 2012–2016

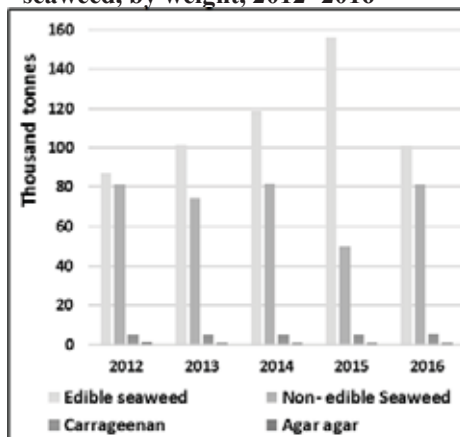
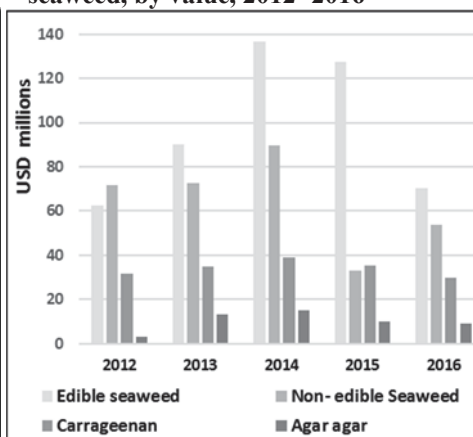


Figure 8. Indonesia: Exports of seaweed, by value, 2012–2016



Source: Statistics Indonesia.

Indonesia’s dried seaweed exports are dominated by *Eucheuma* spp. Unprocessed seaweed is categorized into two types in the export trade: food type, fit for human consumption (HS 121221), and non-food type, not fit for human consumption (HS 121229). While exports to Asian markets and Chile are dominated by food-category seaweed, the European Union and the United States of America import nonfood-category seaweed from Indonesia. Exports of food-quality seaweed have increased over the years although in general, both types presently hold almost the same share in the export trade. Nevertheless, it is worth noting that exports of agar agar have dwindled within 1 000 tonnes (+/-) although its average export value has increased to USD 10/kg in 2015 (Table 4).

Until the late 1990s, the dried seaweed exporters in Indonesia were largely dependent on the reprocessing sector, specifically in Denmark. The average FOB export price of Indonesian dried seaweed, however, increased from USD 400/tonne during the late 1990s to USD 800/tonne in early 2000 as a result of strong and stable demand from China.

Table 4. Indonesia: Export price of *E cottonii*, 2015

Dried seaweed (<i>E. cottonii</i>), raw material	Seaweed chips	Semi refined carrageenan	Refined carrageenan (non-food grade)	Refined carrageenan (food grade)
USD0.30/kg	USD2.00/kg	USD3.60/kg	USD12.60/kg	USD14.00/kg

Source: Seaweed Export Industry, Indonesia.

Indonesia also imports seaweed and colloids for use in the local food industry, such as the beverage, food and pharmaceutical sectors. Carrageenan, in particular, is sought by the domestic industry for the manufacture of food jellies, toothpaste, ice cream, canned meat and fish. None of the domestically produced carrageenan or semi-refined carrageenan (SRC), however, is used in the country.

New market trends

In the past few years, there has been a growing trend in the use of seaweed as direct food products in Indonesia. Though a relatively small sector at present, the rising domestic demand is driving the processing of *cottonii* or *Gracilaria* into various food products such as noodles, drinks, crackers, cookies, sweets and tidbits, among others. Throughout the country, these items are produced mainly by small family businesses.



© Sudari Pawiro

Potential and challenges

Indonesia has a vast potential for seaweed farming and export, which is not fully realized as yet. Cognisant of this fact, the government has renewed its intent to modernise and further develop the industry. Among the initiatives being taken is the notion of collective partnerships between local producers and processors; communities; non-government organizations; public- and private-sector representatives; and international organizations.

The Government of Indonesia also has prioritized seaweed in the country's national development plan, not only due to its export earnings but also because its farming has obviously assisted in improving the livelihoods of coastal communities. Various programmes have been launched to increase seaweed production, such as providing better quality seed, improving farming techniques, zonation and enhancing post-harvest and processing technologies. As a result, small fishermen in many areas of Indonesia have changed their profession from fishing to the farming of seaweed to increase their incomes.

Since 2014, Switzerland's State Secretariat for Economic Affairs has funded the SMART-Fish Indonesia programme, implemented by the United Nations Industrial Development Organization together with the Indonesia's Ministry of Marine Affairs and Fisheries. The programme aims to improve the productivity of the seaweed value chain in Indonesia, as well as the competitiveness of the Indonesian seaweed industry

2.1.3 Malaysia

Production of seaweed (farmed)

A coastline of over 3 500 kilometres, with an extensive continental shelf area, has provided opportunities during the last decade to increase seaweed farming in Malaysia. Mariculture activities for seaweed centre around Sabah, particularly in Kudat and Semporna where the agro-climatic environment is ideal for farming seaweed. The main species of seaweed cultured is *E spinosum* in Kudat and *E cottonii* (*Kappaphycus*) in Semporna.

Production increased significantly, from 60 000 tonnes in 2006 to 261 000 tonnes in 2015 (Table 5), supported by the local Government of Sabah's initiatives through technical collaboration between the Department of Fisheries, research institutes (University of Malaya, Sabah Unit) and the aquaculture industry in Malaysia – particularly in Sabah, where seaweed farming has become a major activity during the last seven to eight years. Malaysian seaweed production reached the highest level at over 330 000 tonnes in 2012. However, disease and low-quality seed problems affected the aquaculture sector during the subsequent years.

Table 5. Malaysia: Aquaculture production of seaweed, 2008–2015

	2008	2009	2010	2011	2012	2013	2014	2015
Tonnes	111 298	138 857	207 892	239 450	331 490	269 431	245 332	260 760
USD thousands	6 686	7 884	17 444	21 919	23 616	25 672	63 752	33 577

Source: FAO.

The farming technique engaged in Malaysia is the monoline method, similar to that practised in Indonesia and the Philippines. The common seaweeds in national waters are green seaweed (*Caulerpa* and *Ulva*), brown sea weed (*Sargassum*, *Tubinaria*, *Dictyota* and *Padina*), and red seaweed (*Gracilaria*, *Eucheuma* and *Laurencia*) according to the Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asian and Pacific Region (INFOFISH).



Monoline culture of seaweed.

© Fatima Ferdouse



© INFOFISH

Coastal farmers in the Semporna area have largely benefited from seaweed aquaculture. Increased demand from China, as well as from the local seaweed processing industry, has boosted the FOB price of dried seaweed from USD 400/tonne during the late 1990s to USD 800/tonne in the early 2000s. The carrageenan processing industry in Sabah, mostly Tawau, has been the main customer for local dried seaweed.



Seaweed mariculture and drying facilities in Semporna, Malaysia.
© Fatima Ferdouse.

Dried seaweed in Malaysia is used as food for human consumption, animal feed, fertilizer and in traditional Chinese medicine. The seaweed-producing industries generally use *Eucheuma* as the main raw material for manufacturing semi-refined carrageenan (SRC) and refined carrageenan (RC). Species such as *Gelidium* and *Gracilaria* are also used to make agar on a small-scale basis. Agar agar, however, is imported for direct usage as food.



Agar agar is popular as a dessert item and as a content of drinks in Malaysia.

© Fatima Ferdouse

Major seaweed processing industries/factories, established in Sabah, produce food and nonfood-grade SRC and RC. While most of the products are exported, there is an increasing demand for grades of carrageenan from the domestic industries in Malaysia. Tacara Sdn. Bhd, based in Tawau (Sabah) is one of the leading producers of carrageenan in the country.



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Import-export trade

Until 2014, the main component of Malaysia's seaweed exports has been dried carrageenophyte, and the country is one of the producers in Southeast Asia of high-grade carrageenophytes. The trend changed, however, during 2015 and 2016 when carrageenan exports declined significantly and dried seaweed exports increased, particularly to China (1 588 tonnes in 2016) (Table 6). In 2016, the export value of seaweed, including

carrageenan, totalled USD 8.45 million, and the leading markets for carrageenan were the European Union, Thailand, Viet Nam and the United States of America.

Table 6. Malaysia: Exports and imports of dried seaweed, carrageenan and agar, 2014–2016

	Weight in tonnes					
	2014		2015		2016	
	Exports	Imports	Exports	Imports	Exports	Imports
Dried Seaweed	709	1 106	2 378	1 121	2 226	1 295
Carrageenan	1 018	997	798	1 019	573	977
Agar agar	11	680	126	531	42	532
Total	1 738	2 783	3 303	2 671	841	2 804

Source: Department of Statistics Malaysia.

In the category of seaweed and other algae fit for human consumption, Malaysia exported 2 224 tonnes valued at USD 1.8 million in 2016. Except for the peak in 2015, this figure represented a significant increase over preceding years (Table 7).

Table 7. Malaysia: Exports of seaweed and other algae HS 121221, fit for human consumption, 2013–2016

	Weight in tonnes; value in USD thousands							
	2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
China	388	465 288	586	984 102	1 502	146 6753	1 588	1 156 297
Philippines	0	0	21	9 060	723	315 550	558	219 987
Indonesia	25	34 739	27	31 114	1	5 681	40	10 7973
Japan	0	0	8	56 411	8	52 529	16	112 074
United Kingdom	44	92 851	44	195 535	0	0	15	71 600
Singapore	44	257 230	1	40 384	3	4 677	3	20 769
Hong Kong SAR	6	24 782	0	0	1	10 471	3	63 560
Total (including others)	550	921 353	687	1 326 223	2 261	1 871 361	2 224	1 763 940

Source: Department of Statistics Malaysia.

It is important to note that imports of seaweed raw materials and refined products were at a record high in Malaysia, exceeding 2 800 tonnes in 2016, with an import value of USD 27.1 million. This made Malaysia a net importer of seaweed in terms of quantity as well as in value. The previous year saw a similar trend.

One of the reasons behind the rising imports of seaweed into Malaysia could relate to the increasing usage of carrageenan in the domestic food industry (e.g. ice cream, meat binders) and the chemical/pharmaceutical industries (e.g. toiletries). Agar agar is popular for the preparation of desserts at home and in the catering sector; its usage is also on the rise in the ready-meal processing industries. Companies dealing in chemicals and food additives are the main buyers of carrageenan in Malaysia. In addition, they import supplies via Singapore and directly from sources such as China, as well as of late Indonesia.

Outlook for the seaweed sector

According to Malaysia's Department of Fisheries, the aquaculture production forecast for the country in 2017 is 1.44 million tonnes, of which approximately 730 000 tonnes will comprise seaweed. In line with this expected volume, farming of *Gracilaria* is likely to increase due to the rising consumer demand for agar, which is currently being met through imported supplies. Demand for carrageenan is also expected to increase with the rising utilization of phycocolloids in the food and non-food sectors in Malaysia.

2.1.4 Thailand

The domestic production of seaweed is relatively low in Thailand. Because the consumption or usage within the country is high in the food and non-food sectors, however, Thailand is a net importer of seaweed and hydrocolloids.

Generally, Thailand imports edible seaweed such as dried *wakame*, *nori* and agar agar strips and powder for direct consumption. China and Republic of Korea are the principal sources of dried edible seaweed (Table 8).

Imported dried edible seaweed from Chile is used to produce agar powder for direct consumption. Besides marketing the agar agar locally, Thailand exported nearly 200 tonnes of the product in 2016, mainly to Australia, the Republic of Korea and the United States of America (Table 9).

Hydrocolloids (carrageenan, agar agar and alginic acid) are imported for the large food processing sector in the country, which manufactures a wide range of 'ready to cook' and 'ready to eat food' for local and export markets. The import of carrageenan has increased over the years (Table 10). Besides food for human consumption, there is a large export-oriented pet food industry in Thailand that uses seaweed products as a binder.

Table 8. Thailand: Imports of seaweed and other algae HS 121221, fit for human consumption (by origin), in tonnes, 2012–2016

	Weight in tonnes				
	2012	2013	2014	2015	2016
Korea, Republic of	515	1 404	2 020	2 556	3 066
China	1 230	1 053	1 099	921	1 206
Chile	189	160	108	133	128
Indonesia	106	56	109	163	54
Norway	0	1	0	0	51
Japan	31	42	51	59	45
Total weight (including other minor suppliers)	2 121	2 759	3 408	3 837	4 554
Total value in USD thousands	15 417	25 900	36 334	40 690	56 450

Source: Customs Department, Thailand.

Table 9. Thailand: Imports of agar agar (HS 130231), 2012–2016

	Weight in tonnes				
	2012	2013	2014	2015	2016
China	587	527	639	581	612
Chile	122	96	90	99	85
Taiwan, Province of China	0	0	31	15	16
Indonesia	4	8	6	12	10
India	8	46	48	72	5
Total weight (including other minor suppliers)	724	695	818	812	731
Total value in USD thousands	9 264	10 119	11 241	11 800	11 595

Source: Customs Department, Thailand.

Table 10. Thailand: Imports of carrageenan (HS 130239), in tonnes, 2012–2016

	Weight in tonnes				
	2012	2013	2014	2015	2016
Philippines	988	801	1 040	894	1 136
United Kingdom	801	656	660	759	870
Canada	17	246	520	552	707
United States of America	145	183	194	161	216
China	90	101	118	149	155
Denmark	122	110	91	120	96
India	73	50	61	58	72
Indonesia	20	46	53	45	70
Korea, Republic of	125	143	57	58	64
Malaysia	39	35	34	46	45
Peru	0	0	24	21	31
Japan	15	17	27	21	30
Australia	12	10	13	10	13
Total weight (including other minor suppliers)	2 549	2 629	2 918	2 940	3 517
Total value in USD thousands	21 645	24 090	22 475	21 113	23 954

Source: Customs Department, Thailand.

2.1.5 Philippines

Seaweed from aquaculture

The Philippines is the world's third largest producer of seaweed, following China and Indonesia. There are some 800 species of seaweed in national waters of which *Eucheuma spp* is the most commercially significant, followed by *Caulerpa*, *Gracilaria* and *Sargassum*. In 2015, about 90 percent of the farmed output from the Philippines comprised *Eucheuma spp*, namely, *E. cottonii* (*Kappaphycus*) and *E. denticulatum*, and the rest was green seaweed. In fact, nearly 80 percent of the world's total *E. cottonii* (*Kappaphycus*) production originates from the Philippines (777 963 tonnes), roughly 30 percent of which is traded in dried form.

The farming of these seaweed species, particularly in the southern part of the country, generates income for more than 500 000 people from over 100 000 families living along coastlines and on the many islands. In addition, at least 10 000 job opportunities have been created through processing and other related activities. Wild harvests are insignificant by comparison; the species involved are mainly *Sargassum*, *Gracilaria*, *Gelidium* and *Porphyra* spp.

The major producing areas are Tawi-Tawi, the reef areas of Sulu, Zamboanga del Norte, Sacol and Cuyo Islands of Palawan, Dawajon of Central Visayas, Pangasinan, Mindoro, Negros, Panay, Leyte and Camarines Sur. Mindanao island is the leading region, producing more than 50 percent of the country's seaweed volume.

During 2016–2015, aquaculture production of seaweed in the Philippines reached its highest point in 2011, at 1.8 million tonnes, but dwindled during the next three years because of the highly intensified nature of the farming system and subsequent disease-related issues. By 2013–2015, the annual production stabilized at around 1.55 million tonnes, with a marginal rise in 2015 (Table 11).

Table 11. The Philippines: Production of seaweed (by species), in tonnes, 2011–2015

ASFIS Species	Weight in tonnes				
	2011	2012	2013	2014	2015
Elkhorn seamoss	1 697 682	1 608 401	1 428 707	1 434 714	1 457 865
Spiny <i>Eucheuma</i>	136 183	137 603	124 218	113 127	106 950
<i>Caulerpa</i> seaweeds	5 145	3 928	3 029	1 199	1 219
<i>Gracilaria</i> seaweeds	1 823	1 139	2 424	536	327
Total (farmed)	1 840 833	1 751 071	1 558 378	1 549 576	1 566 361
Total (capture & culture)	1 841 291	1 751 476	1 558 778	1 549 943	1 566 728

Source: FAO.

In addition to being the world's third largest producer of seaweed (approximately 14 percent of global output), the Philippines is also the second largest exporter of SRC to the international market. It lost its top ranking to China during the mid-2000s.

C.crispus and *Gigartina*, which grow naturally in their habitat, continue to be harvested as raw material for carrageenan extraction, although currently around 70 percent of the carrageenan production in the country is derived from cultured seaweed (mainly *Eucheuma*). In the late 1960s, some experiments were initiated in the Philippines on the culture of *Eucheuma* by Maxwell Doty of the University of Hawaii under the sponsorship of FMC Corporation. The trials eventually became so successful that today the Philippines supplies approximately 80 percent of the world's *Eucheuma* requirements for the production of carrageenan.

International trade

The seaweed aquaculture sector in the Philippines is highly export-oriented. According to the Philippine Statistics Authority, exports of seaweed (and other algae) and carrageenan in 2016 totalled nearly 43 000 tonnes at a customs declared value of USD 200 million (Annexes 11a, 11b and 11c; Table 12).

Table 12. The Philippines: Exports of dried seaweed, carrageenan, and agar agar, 2013–2016

	Weight in tonnes; value in USD thousands							
	2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Dried seaweed	37 063	34 356	18 493	49 300	14 910	21 739	11 052	8 539
Carrageenan	23 503	195 242	26 633	213 239	27 181	185 461	31 813	190 171
Agar agar	2	11	1	10	2	6	1	1
Total	60 568	241 012	45 675	272 306	42 093	213 508	42 866	199 973

Source: Philippine Statistics Authority.

During the 2013–2016 period, there was an overall marked decline in the exports of seaweed and other fresh or dried algae, despite individual fluctuations by country (Annex 11a). China, Denmark, France, Hong Kong Special Administrative Region, the Republic of Korea, Spain, the United Kingdom and the United States of America were the top destination markets for this product from the Philippines. Unlike the top seaweed exporter, Indonesia, where the products consist mainly of dried seaweed, exports from the Philippines are increasingly dominated by SRC and RC (Annexes 11b and 11c). In other words, dried seaweed exports from the Philippines have declined gradually as more raw materials are being processed into carrageenan products in response to the increasing demand for that product worldwide. During the last six years, the processing industry in the Philippines imported 8 000–10 000 tonnes of dried seaweed annually to supplement supplies of raw material. China, Indonesia and the Republic of Korea have been the main supply sources.

In the same year (2016), the export of value-added seaweed or carrageenan from the Philippines consisted of 74 percent of the country's total seaweed exports, and was at a record high of 31 813 tonnes, valued at USD 190 million. The share of refined carrageenan also increased by 55 percent during the 2012–2016 period.

Processed and semi-processed carrageenan exports were exported to 80 countries worldwide, with the top destinations being the United States of America (9 760 tonnes) and the European Union (7 620 tonnes). In the common market of the European Union, the large importing countries were Belgium, Denmark and the United Kingdom. Other leading markets, in descending order, were Mexico (2 346 tonnes), Thailand (1 928 tonnes) and Indonesia (1 186 tonnes). Compared with 2015, exports to the European Union, Indonesia, Thailand and the United States of America in 2016 had increased (Table 13).

The major markets for raw/minimally processed seaweeds are Brazil, China, France, Thailand and the United States of America. For seaweeds and carrageenan, the composition of the major markets changes to Belgium, Denmark Mexico, Spain, Thailand and the United States of America. The limiting factor in the production of refined carrageenan is a lack of sufficient facilities with the appropriate technology.

Table 13. The Philippines: Exports of processed and semi-processed carrageenan (HS 130239), 2012–2016

	Weight in tonnes				
	2012	2013	2014	2015	2016
United States of America	7 495	7 498	7 387	8 431	9 762
Mexico	1 146	1 704	1 621	2 821	2 346
Thailand	832	891	1 202	1 066	1 928
Belgium	1 753	1 500	1 592	1 504	1 897
Denmark	1 302	1 221	1 090	1 265	1 366
United Kingdom	791	1 293	805	1 082	1 187
Indonesia	304	298	528	357	1 186
Brazil	924	776	720	777	931
China	524	507	475	476	918
Australia	735	772	974	902	913
Russian Federation	883	618	765	853	823
Germany	990	739	1 337	591	803
Spain	655	480	396	415	759
Argentina	488	446	768	621	598
Japan	260	401	463	532	543
Viet Nam	92	122	321	169	531
Malaysia	146	197	384	300	525
Total (including others)	24 035	23 503	26 633	27 181	31 813

Source: Philippine Statistics Authority.

Domestic market

Annual imports of agar agar into the Philippines range between 20 tonnes and 25 tonnes, of which 60 percent is used by the food industry, followed by biotechnological applications and the pharmaceutical industry. Although demand appears to be increasing from several industries (meat and poultry processing, food and pet food), the local market for SRC and RC remains relatively small.

Agar strips, referred to as ‘gulaman’ bars made from *Gracilaria spp*, are sold on the domestic market. These are produced by small- to medium-scale manufacturers in Manila and Bulacan. In the northern coastal communities in Luzon and Central Visayas, seaweed has long been used as a part of vegetable salads. Several types of seaweed are easily available in Manila and other local markets, and there is slow albeit increasing demand from consumers throughout the country. *Gracilaria*, *Codium*, *Caulerpa*, *Porphyra spp.*, *Hydroclathrus*, *Hypnea*, *Laurencia* and *Eucheuma* are consumed fresh in salads while

species, such as *Porphyra*, *Ulva*, *Laurencia*, *Colpomenia*, *Acanthophora* and *Halymenia*, are sold in dried form and then soaked in water to recover its fresh state before preparation into salads. Some species are first boiled before they are added to salads or made into gelatine or jelly desserts. The young shoots of *Sargassum* are used in soups or mixed with coconut milk to make vegetable dishes according to INFOFISH.



Caulerpa spp. makes a colourful and crunchy addition to salads.

© Fatima Ferdouse

A positive point about the seaweed industry in the Philippines is the fact that there is an effective collaborative network between the local authorities, such as the Bureau of Fisheries and Aquatic Resources (BFAR) and other stakeholders (non-government organizations, cooperatives and research institutions) that aim to strengthen farming, processing and trade activities relating to seaweed.

BFAR has identified several challenges in the sector at the local level: pollution in production areas, inadequate supply of dried seaweed for processing, the security situation in the producing areas in the southern part of the country, diseases such as ice-ice (between 2011–2013, for example, the Philippines lost a potential seaweed harvest worth USD 300 million as a result of ice-ice), and inconsistency in the quality of the seaweed produced. Internationally, BFAR warns of increasing competition in the production of *Eucheuma* vis-à-vis countries such as Indonesia and Malaysia.

Republic of Korea

According to FAO, the Republic of Korea is the fourth largest producer of farmed seaweed. Production has remained relatively stable over the last decade, with a marginal rise in 2015 at 1.2 million tonnes compared to 1.1 million tonnes harvested in 2014.

While a major part of the production is consumed locally, the country is also a net exporter in the seaweed trade in terms of quantity and value. In 2016, exports totalled 34 500 tonnes at a value of USD 222 million, largely dominated by edible seaweed (32 000 tonnes) which was 15 percent more than the quantity exported in 2012. The main markets were China, Japan and Thailand. The other important exportable in this product group was carrageenan, for which exports fluctuated between 2 200 tonnes in 2012 to 2 500 tonnes in 2016, valued at USD 22 million. Notably, the market also imported 15 000 tonnes of seaweed in 2016, valued at USD 31 million. The main products were edible seaweed (12 000 tonnes) and carrageenan (1 300 tonnes).

Dried seaweed is a favourite addition in many dishes in the Republic of Korea. It can be a part of traditional rice rolls (*kimbap*); roasted with sesame oil and eaten together with rice and *kimchi*; pressed into a dark green sheet known as *kim*; enjoyed as a crispy, flavoured seaweed snack; prepared as an addition to salads and soups; among others. In 2015, dried seaweed exports were valued at USD 300 million, almost three times higher than the figure in 2010. Dried seaweed is now in second place in export rankings, following that for tuna. The main market was the United States of America followed by Japan, Thailand, China and the Middle East.

Dongwon F&B Co. Ltd., the nation's largest dried seaweed producer, created a product called 'Sea Veggies' for the U.S. market. Once this company has received its halal food certification, it is expected to make a significant push into Middle Eastern markets. While sales in the United States of America have risen due to the perception that these products are healthy non-sugar snacks, its popularity in China and Southeast Asia is considered a result of the Korean pop culture craze.

Where the Republic of Korea seeks to differentiate itself from Thailand's successful snack industry is to offer more flavours, such as barbecue, wasabi and squid, and to introduce innovative products. An example is a snack that consists of dried laver and brown rice chips, marketed by CJ Cheiljedang, the country's largest food company. Apart from the United States of America, seaweed snacks in the Republic of Korea are sold under the brandname 'Bibigo' in 20 other nations. The authorities also are trying to promote Korean dried seaweed as *kim* in an effort to create a different market niche from Japanese *nori*.

2.2 EUROPE

2.2.1 European Union

Several market studies indicate that seaweed product innovation is at its highest rate in the Asia and the Pacific region (more than 80 percent), with Europe second, followed by North America.

In Europe, the single most important reason is the expanding consumer view of seaweed as a type of healthy ‘superfood’. A walk through major supermarkets in Europe will reveal a large number of foods, seasonings and drink items containing seaweed and/or its flavor. Furthermore, if they carry an organic label – as many do – they can be sold at a premium.

Table 14. European Union: Exports of seaweed, 2012–2016

	Weight in tonnes				
	2012	2013	2014	2015	2016
Seaweed for human consumption	3 733	4 691	5 041	5 219	4 607
Seaweed not for human consumption	35 138	42 910	48 833	55 974	53 723
Agar agar	2 897	2 431	2 634	2 766	2 462
Carrageenan	40 403	45 379	46 939	37 587	40 802
Total	82 171	95 411	10 3447	101 546	101 594

Source: Eurostat.

Table 15. European Union: Imports of seaweed, 2012–2016

	Weight in tonnes				
	2012	2013	2014	2015	2016
Seaweed for human consumption	15 0631	31 768	22 953	1 7175	15 184
Seaweed not for human consumption	21 717	65 882	65 310	89 103	88 485
Agar agar	3 117	4 396	3 359	3 734	4 171
Carrageenan	61 146	72 113	63 302	57 158	70 627
Total	136 611	174 159	159 924	167 170	17 846

Source: Eurostat.

Research into new processing technologies is a clear focus in the European Union. Taking France as an example and provided they meet safety regulations, seaweed is commonly used as a vegetable and condiment in many interesting food products. According to the Center for Study and Promotion of Algae in France, several companies in the region specialize in developing innovative uses for seaweed. Two such companies mentioned in a center’s report are C-Weed Aquaculture (which has its own culture and processing facilities, and produces a range of items that include dried and powdered seaweed); and Algues Services, which produces items for culinary use (e.g. seaweed tartare). C-Weed Aquaculture products have Bureau Veritas (FR BIO 10) organic certification.



Some of the many innovative seaweed products manufactured and sold in Europe.

Such innovation is not limited, of course, to European Union countries within Europe. In Norway, for example, the Norwegian Seaweed Technology Center is described as a knowledge platform for technology development within the industrial cultivation, harvesting, processing and application of seaweed in that country.

2.2.2 Denmark

Denmark has a broad range of industries, ongoing research projects and other activities that involve seaweed, as well as a long history with industrial extraction of seaweed and seaweed research. The company Litex A/S (later FMC Corporation), which was founded in Denmark in 1942, began extracting ‘Danish agar’ from locally available *Furcellaria lumbricalis* seaweed. Later, in 1960, Copenhagen Pectin (today CP Kelco ApS) began to extract carrageenan from imported seaweed; today, this company continues to be one of the world's leading carrageenan producers, with factories in Denmark and the Philippines. This was not least because of the work of the former director of CP Kelco ApS, Hans Porse who, in the 1970s and 1980s, initiated the cultivation of *Kappaphycus* and *Eucheuma* seaweeds in Indonesia and Zanzibar (Tanzania). Commercial carrageenan seaweed cultivation and its extraction now involves approximately 150 000–200 000 people worldwide. Another example is Danisco A/S (today, DuPont™ Danisco®), which is perceived to be the world's largest food ingredients joint company. Based in Denmark and with factories in Chile and France, it has for many years also been involved with the manufacture of alginate and carrageenan.

While Denmark has been a leader for hundreds of years in the field of seaweed research, its industry and academia have maintained a profound interest in seaweed. Currently, several research groups from the six national universities in Denmark are involved in seaweed research in terms of the screening of biochemical and bioactive compounds; gastronomy; feed; multi-extraction/biorefineries, where residuals are utilized as fertilizer and/or bioenergy; and cultivation and crop improvement. Meanwhile, Danish companies are involved in the extraction of biochemical; product development, including inclusion of seaweed; modeling of farms and extractive potential; and cultivation and crop improvement of seaweed, among others. The use of the local, sustainable, palatable ‘new’ resource continues to be of interest to the media and new customers, and the demand for these products is increasing.

Private investments are driving the expansion of small- and medium-sized businesses in the production of seaweed food products. A recently significant example is the funding that has been provided by the Karl Pedersen and Wife’s Industrial Foundation (founder

of Copenhagen Pectin) to support the Danish Seaweed Organisation's initiative to gather the local players in the seaweed industry and create a marketing platform for companies to enhance visibility and export, as well as to support each other. Applied research funding is also offered, in particular for proposals based on collaboration between research bodies and companies on all aspects of the cultivation and utilization of seaweed. Companies also are able to apply for investment or shared funding for innovative ideas.

Denmark's National Strategic Plan for the Development of Sustainable Aquaculture 2014-2020 forecasts an increase of at least 25 percent of fish and shellfish (from 44 000 tonnes to 55 000 tonnes). Seaweed is referred to therein as an initiative to bioremediate waste nutrients in water environments (MEF, 2016), and its use as feed also is stated to reduce the import of vegetable protein sources. In 2016, the Government of Denmark explored the potential for creating aquaculture zones to include fish, shellfish and seaweed, as well as possible areas to combine these species.

The Danish AgriFish Agency of the Ministry of Environment and Food has a report that examines the potential for and challenges to the cultivation of mussels and seaweed. The most significant barrier to development was identified as financing (Petersen *et al.*, 2016)). A couple of the points to be considered are the (i) identification and documentation of the potential for, and costs related to, seaweed cultivation in Danish waters; and (ii) development of cost-effective technologies for species that have significant volume and value prospects.

Another recent report, "Growth within the blue biomasses", released by Innovation Network for Biomass, Danish Food Network, and others (Andersen *et al.*, 2016) is also worth reading. It focuses on the potential, challenges and recommendations in the cultivation of seaweed and shellfish.

Main commercial seaweed species

Denmark is a small country with a long coastline of 7 300 kilometres with a salinity gradient from the northern part (~35 practical salinity unit) to the southern waters (~10 practical salinity unit), towards the brackish Baltic Sea. This causes a significant decline in the number and size of seaweed species – from between 350 and 500 species in the north down to less than 50 species in the south. Exploitation of various seaweed species in Denmark's waters has been challenging, although with further research, the low, saline areas necessary for the cultivation of seaweed could be found. For now, however, there are only more or less ten species that are of commercial interest from wild and cultivatable sources.

The establishment of seaweed farms can take place once the Danish Coastal Authority has carried out an initial review of the impact on the surrounding nature and the potential for an environmental impact assessment. A license is typically valid for five years with the option for extension. Seaweed also can be cultivated organically based on certification from the Ministry of Environment and Food. In brief, neither non-organic fertilizers nor nutrient additions can be used in the initial stages of cultivation; the location should be classified as a suitable area for organic aquaculture; boats that work in the area should be free of anti-fouling on the hull, among other conditions. The gathering of seaweed for private consumption or sale is not legally prohibited.

The species cultivated commercially at present on a large scale is the brown sugarkelp (*Saccharina latissima*). This species is also collected from the wild for commercial purposes (i.e. human consumption) as are the bladderwrack (*Fucus vesiculosus*), serrated wrack (*Fucus serratus*) and smaller amounts of dulse (*Palmaria palmate*). Research is being carried out on the cultivation of *Palmaria palmate* and, to some extent, *F. vesiculosus* and *Laminaria digitata*.

Farming was carried out in seven licensed areas over the 2011–2015 period, with the largest being 1 square kilometre. These areas are mainly used for commercial cultivation of *Saccharina latissima* as well as for pilot trials relating to *Palmaria palmata* and *Fucus vesiculosus*. Production volume has increased from 1 tonne in 2009 to 10 tonnes (wet weight) in 2014. An unexpectedly high volume was reported in 2013; however, this figure is questionable and has not been verified.

Approximately 20 companies harvest local and natural populations of seaweed, with most manufacturing products for the niche and local markets, such as snacks, pesto, pickled seaweed and mustard. When evaluating the use of seaweed as a food, the chemical risk assessment must take into account all regulations that relate to heavy metals, inorganic arsenic and iodine. Table 16 indicates the thresholds for seaweed as a food in France and the United States of America, as well as a dietary supplement in the European Union. It should be noted that European Union regulation does not include inorganic arsenic and iodine, and that the regulations of France and the United States of America differ in iodine threshold concentrations.

Table 16. Threshold levels for minerals and heavy metals in edible seaweed sold in France, the European Union and the United States of America

Toxic minerals	Limit (mg kg ⁻¹ dry matter, ppm)		
	France	USA	EU regulation
Inorganic arsenic	<3.0	<3.0	No regulation
Lead	<5.0	<10	<3.0
Cadmium	<0.5		<3.0
Tin	<5.0		
Mercury	<0.1		<0.1
Iodine	<0.5	<5,000	
Heavy metals		<40	

Source: “Other References” in Holdt and Kraan, 2011.

Analyses of Danish seaweed species indicate that, in general, inorganic arsenic concentrations (and non-harmful species of arsenic) are below the standards set by France and the United States of America. For food use, however, the standard is based on total arsenic, with a threshold level of 40 parts per million. This concentration is reached by *Saccharina latissima* several months a year. Lead and mercury concentrations are also below threshold values, whereby cadmium (up to 1.22 milligram (mg)/kg for *S. latissima*) is below European Union regulation (<3.0 mg/kg), but not at the threshold value set for France (<0.3 mg/kg) for a certain period in the year. Iodine concentrations in some large

brown kelps are extremely high and this also applies to the Danish specimen of *S. latissima*, which has concentrations up to 6 110 mg/kg. There is no standard with regard to iodine in food supplements in the European Union, although the concentration threshold is more than ten times higher than that set by France (<0.5 mg/kg) and above that of the United States of America (<5 000 mg/kg). Conclusively, therefore, iodine is the element that limits the recommended daily consumption of seaweed. Little is known, however, of the bioavailability and uptake of iodine, which also applies to the other seaweed heavy metals.

Processing

The major commercial seaweed-based product for human consumption in Denmark is dried seaweed. This is sold as flakes or powder, or is mixed as a sea salt, pesto, mustard and oil.

The processing technique for dried seaweed involves the collection of natural or cultivated seaweed. This is then washed in seawater or fresh water and hung to dry in a closed room with a dehumidifier. Once it is of a crispy texture, the seaweed is homogenized and sealed in a plastic pack or plastic/glass jar, mixed with some sea salt and/or spices. Seaweed pesto has become considerably popular and is sold as normal pesto or as a dried version that has a longer shelf life and requires the addition of oil and water before use. The pesto is made mainly of *Fucus* sp. and *Saccharina latissima* (47 percent), freshly collected from wild populations, washed in fresh water, boiled and finely cut, and later mixed with other ingredients. Seaweed oil is made by homogenizing rapeseed oil with an entire piece of dried *Fucus serratus* (2 percent); the freshness from the seaweed complements the lipids in the oil. Other products that include seaweed are many and are used fresh, fresh frozen, or dried.

Any company venturing into seaweed farming must register at the Ministry of Environment and Food, undertake a risk evaluation process of activities in the water area, provide an analysis of the species and their composition, and demonstrate the know-how of handling seaweed. The Ministry sets and implements the seaweed product standards for Denmark, which include food safety regulations, company responsibilities, among others.

More specifically, the following applies:

- Food safety: Food cannot be marketed if considered dangerous, marketing cannot be misleading, and the food company has the responsibility to comply with the relevant regulations, ensure product traceability, and ensure the withdrawal of potentially dangerous foods.
- Hygiene at the source: The regulation regarding the cultivation and harvest of natural populations includes protection against contamination, surveillance of zoonosis, assurance that the environment (e.g. equipment) and products are kept clean, assurance that drinking water or clean water is used, employee health issues, securing against possible pests and waste handling, among others.

- Hygiene in processing: These standards address facilities such as toilets, sinks, ventilation, building cleanliness, transport, equipment, food waste, water supply, personal hygiene and packaging;
- Novel food: Food and food ingredients must be approved in the European Union if they have not yet been consumed in notable amounts before May 15, 1997. Species such as *Saccharina latissima*, certain *Laminaria spp* and *Porphyra purpurea* are well recognized and do not require further approval. *Palmaria palmate*, however, is labeled “Any other food uses of this product (other than as food supplement) have to be authorised pursuant to the Novel Food Regulation”, given that the European Union views it only as a food supplement.
- Chemical contamination: Generally relates to compounds such as iodine, cadmium and arsenic (inorganic arsenic);
- Natural toxic compounds: Possible natural toxic compounds also should be taken into account; for example, kainic acid in *Palmaria palmata*;
- Labelling and claim: Prepackaged food should be labelled with product information. Statements, logos, pictures, symbols and trademarks that indicate nutritional or health properties about a given product or the effect on one’s health are considered nutritional or health claims;
- Materials that come into contact with foods: In general, the materials that come into contact with food should not release compounds in concentrations that may affect one’s health.

More details on seaweed as a food and its relevant standards are found on the website of the Ministry of Environment and Food of Denmark (MEF, 2016b).

Marketing and trade of seaweed and seaweed products

Exports

Exports of seaweed for human consumption reached a peak in 2012 at 609 tonnes (USD 4.7 million) and, thereafter, steadily declined to 361 tonnes (USD 2.9 million) in 2016 (Table 17).

Imports

Records indicate that except for a peak of 191 tonnes in 2014, imports of seaweed for human consumption remained fairly stable in succeeding years. Imports included *nori* sheets for sushi; other dried seaweed; and *wakame* mixed salad. Imports not for human consumption, however, were much higher in comparison, peaking to 6 866 tonnes (USD 1.2 million) in 2013. Between 2014 and 2016, there was some fluctuation, settling at 5 400 tonnes in 2016 (Table 18). The latter imports were mainly used for hydrocolloid extraction.

Imported and exported seaweed were both recorded as ‘seaweed and other algae, fresh, refrigerated, frozen or dried, also grinded’ (i.e. combined nomenclature) until 2011. Microalgae imports into Denmark are included in the figures, albeit as minor contributors.

Table 17. Denmark: Trade in seaweed, 2012–2016

	2012	2013	2014	2015	2016
Exports of seaweed for human consumption (HS 121221)					
Tonnes	609	549	364	364	361
USD	4 737 000	4 575 000	3 332 000	2 853 000	2 880 000
Exports of agar agar (HS 130231)					
Tonnes	1	7	16	27	23
USD	79 000	632 000	594 000	633 000	491 000
Imports of seaweed for human consumption (HS 121221)					
Tonnes	145	117	191	184	175
USD	1 767 000	2 207 00	1 963 000	1 632 000	1 760 000
Imports of carrageenan (HS 130239)					
Tonnes	4 647	5 198	4 714	5 601	5 009
USD	52 262 000	57 970 000	59 974 000	62 750 000	48 360 000
Imports of agar agar (HS 130231)					
Tonnes	126	106	88	95	119
USD	3 277 000	3 288 000	2 784 000	2 644 000	3 350 000

Source: Eurostat.

Table 18. Denmark: Imports of seaweed not fit for human consumption (HS 121229), 2012–2016

	Weight in tonnes				
	2012	2013	2014	2015	2016
Tanzania	2 881	2 652	1 794	2 658	1 883
Indonesia	878	1 278	722	1 152	1 581
Chile	1 376	1 679	1 755	1 820	1 459
Canada	862	703	769	167	191
Netherlands	20	11	48	108	73
Norway	25	40	46	26	57
Italy	0	0	2	8	50
Lithuania	0	0	1	0	29
Philippines	36	18	0	0	26
Morocco	0	237	283	123	26
Total weight (tonnes)	6 924	6 866	5 533	6 244	5 401
Total value (USD thousands)	10 205	12 197	11 708	10 308	6 400

Source: Eurostat.

Domestic demand

The per capita consumption of seaweed in 2015 was estimated at 34.2 grams per annum (Statistics Denmark, 2016). Seaweed has received considerable attention from the media and is promoted as a healthy, sustainable ‘super’ food, substantiated by a Michelin-star restaurant. In addition, the sushi ‘wave’ has found ground in Denmark and, for this reason, seaweed has become popular on the menu or to be eaten by most Danes. This is due to the *nori* sheets that are wrapped around the rice and the *wakame* salad side dish that can be purchased or taken away at sushi restaurants and outlets, let alone sold frozen or fresh at fish stores. Several cookbooks in Denmark relating to seaweed have been launched or

are in the process of production. Nevertheless, seaweed has yet to find its way into normal, everyday or traditional Danish cooking.

2.3 AFRICA

2.3.1 South Africa

South Africa extends from the Orange River and the Mtamvuna River. It includes the coasts of the Northern Cape, Western Cape and Eastern Cape provinces. Overall, the area encompasses 23 individual seaweed concession areas (Seaweed Rights Area – SRA).

South Africa is believed to have a commercial seaweed industry that dates back to the 1950s that includes the collection of beach-cast materials and the cutting of living kelps for export, as well as the production of agar (jelly), alginate, powdered kelp, fish feed, plant growth stimulants and soil conditioners. To date, seaweed resources are considered under-exploited.

South Africa's wild seaweed industry is believed to be well protected under its Marine Living Resources Act, 1998, and the functional concessional protocols in place. For instance, the management and regulatory structure of the annual Recreational Fishing Permit allows individuals access to 10 kg a day of fresh seaweed. Permits are purchased from any local post office and the collection of fees is periodically monitored by fishery officers during beach patrol.

In 2010, approximately 7 602 tonnes (wet weight) of mixed seaweed species were collected from the wild and 2 015 tonnes (wet weight) were harvested from aquaculture systems (DAFF, 2011). There are indications, however, that cultured output could overtake wild harvests over time. This will implicate the country's abalone (*Haliotis midae*) industry which uses almost all collected and harvested seaweed as fresh feed material. In fact, the industry invests millions of rand, annually, in equipment, government dialogue and research in order to farm seaweed for use as natural feed for stocks.

Only a small amount of seaweed in South Africa goes towards human consumption and therefore, there is no relative subsistence or commercial seaweed fishery farming. There is, nevertheless, substantial evidence of a growing cottage industry that utilizes fishing permits within a recreational fishery context to collect beach-cast and forage for seaweeds for the preparation of various meals and drinks that are consumed locally. Some culinary delights made with seaweed range from soft seaweed couscous salad starters to *nori* chips and sustainable seaweed sushi, kelp lasagna main courses and kelp candy or kelp-cocoa ice cream deserts, as well as seaweed cocktails and beer. There also are some food businesses and restaurants (e.g. Cape Farmhouse and SexyFood South Africa) that forage for ingredients for their Fresh from the Sea range of dishes.



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As previously mentioned, the farming of seaweed for direct human consumption does not take place on a significant scale in South Africa in comparison to other countries in the region (e.g. Tanzania's Seaweed Community Cluster Initiative in Zanzibar). Improving an understanding and awareness of the use of seaweed in human nutrition within the country cannot be over-emphasized to stimulate the improved management of resources at sustainable levels when facilitating commercial development and promoting socio-economic benefits, such as nutritional security and poverty reduction.

Main commercial seaweed species

Around 900 species of seaweed were identified in 2012 within South Africa's concession and seaweed management areas, demonstrating the richness and diversity of its coastal marine flora. Of this flora, only 12 species, belonging to six genera, are understood to be commercially exploited, such as *Ecklonia* and, to a lesser extent, *Laminaria*, *Gracilaria*, *Gelidium*, *Gigartina* and *Porphyra*. Positive steps are being taken in the industry to cultivate the more favoured species within a more controlled and disease-free environment. For instance, aquaculture establishments focus primarily on the production of *Ulva* and *Gracilaria* spp. for use as feed in abalone farms and salt production. These two species, together with four others, are common seaweed species collected from shoreline habitats and beach-cast materials, and are used for direct human consumption within the recreational industry of South Africa.

Within this group, *Ulva*, *Porphyra*, and *Laminaria* are mostly consumed for their pleasant flavor. They are also adaptable in a variety of meal presentations.

Farmed seaweed

Aquaculture sites for the production of seaweed in South Africa are located in proximity to the land-based abalone farming sector (e.g HagaHaga in the Eastern Cape). Seaweed species, such as *Ulva* and *Gracilaria*, are grown in ponds and raceways with aeration systems such as paddle wheels.



South Africa: Seaweed aquaculture production system.
© Anderson and Rothman, 2013

Aquaculture production data are not protected, given the commerciality and competitive nature of the industry. In 2013, approximately 2 015 tonnes (wet weight) of *Ulva* were harvested for use as abalone feed. No data, however, were available with regard to the annual production and use of *Gracilaria* seaweed.

Harvested from the wild

Seaweed collection on a commercial scale from the wild is recorded according to its use as feed in abalone farming or for use in the production of plant growth stimulants. In 2011, approximately 6 000 tonnes (wet weight) of *Ecklonia* (kelp) were harvested for use as abalone feed (Amosu *et al.*, 2013; Anderson & Rothman, 2013). A similar volume of kelp is believed to be harvested annually for use in the production of plant growth stimulants (Anderson & Rothman, 2013).



Ecklonia maxima (kelp) being harvested by boat.
© Anderson & Rothman, 2013

Processing

Raw (or minimally processed) seaweed contributes indirectly to the production and nutrient content of food for human consumption through its use in the industrial production of plant growth stimulants and as feed for the abalone industry. Value is added when the wet seaweed is collected and exported for the extraction of colloidal chemicals (e.g. gums, agar, carrageenan, salts and other food supplements) that are used in food production. This has implications for international trade.

Marketing and trade of seaweed and seaweed products

Production and trade data are not available for *Porphyra spp.*, *Plocamium corallorhiza* and *Laminaria pallid*, indicative perhaps of the historical and current low levels of commercial interest or value. Understandably, the scale of South African exports of seaweed is governed by the economic viability of the trade. From 2012 to 2016, the export volume of seaweed did not exceed 2 000 tonnes annually, peaking in 2013 and settling to 1 498 tonnes (USD 2.4 million) in 2016 (Table 19). Fresh kelp is processed locally into plant growth stimulants that are then exported to over 30 countries.

Table 19. South Africa: Export of seaweed, 2012–2016

		2012	2013	2014	2015	2016
Edible seaweed (HS 121221)	Tonnes	269	290	1 050	731	1 299
	USD thousands	670	649	1 357	1 064	1 690
Non-edible seaweed (HS 121229)	Tonnes	1 130	1 379	800	537	134
	USD thousands	937	1 144	1 000	567	402
Carrageenan (HS 130239)	Tonnes	236	325	120	99	65
	USD thousands	1 290	1 808	603	354	265
Total weight	Tonnes	1 635	1 994	1 970	1 367	1 498
Total value	USD thousands	2 897	3 601	2 060	1 985	2 357

Source: South African Revenue Service.



© Anderson & Rothman, 2013

The trade of freshly harvested *Ecklonia* for local use in abalone feed is valued at over ZAR 8 million per annum. On the other hand, *Gracilaria spp* – which are usually processed by simple drying – have a high content of the compounds needed to manufacture agar and gum as a thickener. Market prices, however, often are too low to support a commercial business.

Certain seaweed products – many from China, Japan and the Republic of Korea – are imported into South Africa for direct human consumption and are regularly available in various population clusters such as cities, hospitals and business offices. Imported seaweed products (e.g. Sea's Gift, a Korean seaweed snack (*kim nori*); Mineralife's Daily Multiple - Liquid Wholefood Multivitamin drink; Leafy Greens Nori Wands) also are available in the automated vending sector. Furthermore, seaweed snacks can be purchased online from websites such as www.healthisland.co.za/seaweed-snack/. The actual trade data is not available due to commercial confidentiality. Official data also are unavailable for the small amounts consumed in specialized eateries such as Cape Farmhouse and SexyFood, where the consumption of seaweed (*Ulva*, *Porphyra*, *Gracilaria*, *Laminaria*, and *Ecklonia*) occurs on a national scale.

Overall, therefore, the dominant production and trade of seaweed in South Africa is recognized within the industrial and commercial sectors of abalone and plant growth stimulants. Less known and documented, however, are the production and export trade statistics of dried seaweed for extraction and further processing and – less so – the production, trade and consumption of seaweed in human food. A significantly positive scenario is that the import of seaweed products is regulated according to commodity policy, although volume and value remain undisclosed based on the vulnerability originating from market competition.

2.3.2 Zanzibar (Tanzania)

Of the countries in the continent, Zanzibar(Tanzania) is second to South Africa in terms of seaweed culture and, between 2005 and 2015, the region has been included in the top ten countries listed as seaweed producers (Annex 5). During its peak, seaweed farming contributed about USD 8 million annually to Zanzibar's economy and, in terms of value to the national economy, seaweed comes third following tourism and clove. Seaweed from Zanzibar is exported to China, Denmark, France, the Republic of Korea, Spain, Vietnam and the United States of America.

Currently, however, the industry struggles to remain a major player. Large swathes of seaweed are dying, attributed by researchers to high temperature conditions as a result of climate change. Deeper water culture is one solution, although about 90 percent of Zanzibar's seaweed farmers are women and they traditionally do not swim.

Several remedial initiatives are being promoted by the regional Zanzibar government and various organizations. One company, funded by the Swedish-based Rylander Foundation, established the Seaweed Center in 2011 in the village of Paje on the southeastern coast of Unguja. Here, a team of women make high-quality value-added products such as seaweed powder soap, body oils, shampoos and spice for cakes. Meanwhile, other women are encouraged to farm seaweed in deeper waters with the use of a floating line system.

2.3.3 Morocco

Morocco is the world's fifth largest exporter of agar agar following Chile, China, Indonesia and Spain. Between 2012 and 2016, the annual export volume of agar agar has ranged from 905 tonnes to 1 066 tonnes (Annex 15), with the major markets in 2016 being Japan (240 tonnes) and the United States of America (184 tonnes) (Annexes 22c, 21a, 21b and 21c, respectively). Morocco also imports a small quantity of agar agar (171 tonnes in 2016) (Annex 19).

The source of agar is mainly *Gelidium sp* which grows in the wild. Strong global demand for high-grade agar, however, has resulted in its over-exploitation. Agar is particularly sought after by research institutions, where it is used to culture microbes, and by communities with religious exclusions (Jews, Muslims, Hindus) and vegetarians as a food thickener in place of gelatin (usually from animal sources).

In the 1990s and 2000s, harvesters reported that they were able to collect as much as 500 kg of the seaweed (which they referred to as 'red gold') a day; however, when the total volume collected rose to 14 000 tonnes in 2009, Morocco's marine research institute (Institut National de Recherche Halieutique) raised the alarm. In 2010, the Government of Morocco implemented emergency measures to revive stocks. By the following year, there were signs of a small revival.

In addition to seasonal bans and an annual harvest cap of 6 040 tonnes, the Moroccan government is collaborating in a new initiative, Blue Belt, a project with several African nations working together with FAO and other partners. Initiative objectives include a review of coastal surveillance; and sustainable fishing and aquaculture, particularly in terms of seaweed farming. The Blue Belt initiative also will reinforce the country's Halieutis 2020 strategy, implemented in 2009 to strengthen the Moroccan fishery sector's development and competitiveness.

2.4 SOUTH AMERICA

2.4.1 Chile

There are more than 157 marine resources commercially harvested along the coast of Chile, of which 16 species are seaweed constituting 11.3 percent of Chile's total fisheries production. In 2014, seaweed output amounted to 413 141 tonnes, positioning Chile as the top producer of algal commodities in South America. While the sectors of salmon aquaculture and anchovy/sardine fishery – the major marine products of Chile – have benefitted from significant investments, the production of seaweed essentially is carried out by local fishers.

Macroalgae production in the country has always been highly extractive. In the 1980s, for example, Chile reported seaweed landings of below 200 000 tonnes, all of which were harvested from natural beds (Sernap, 1990), a scenario that continues today. Less than 5 percent of total output in 2014 (Sernapesca, 2015) originated from the aquaculture of *Gracilaria*, which is the only species that has reached commercial level (12 808 tonnes). A few tonnes have been recorded for *Macrocystis pyrifera*, corresponding to pilot/pre-commercial experiences by companies interested in the giant kelp for either

abalone foraging, biofuel trials or as food to a limited extent. Some 3 percent of total production in that year originated from management areas (i.e. delimited marine areas where only fishers from that area can administer, and therefore collect, the biomass of certain resources (seaweed among them)). The remaining biomass corresponded to free access areas, where local fishers listed in the Registry of Artisanal Fisheries are able to collect available seaweed.

The need to increase production levels to meet the growing demand for algal commodities and processed products has led to the Government of Chile designating aquaculture-based systems as a top priority. Currently, at least 15 species are being farmed on an experimental basis, while three species have reached commercial maturity. The sector, however, is a long way from overall profitability, and it depends on many factors, such as production costs, availability of natural beds and market factors.

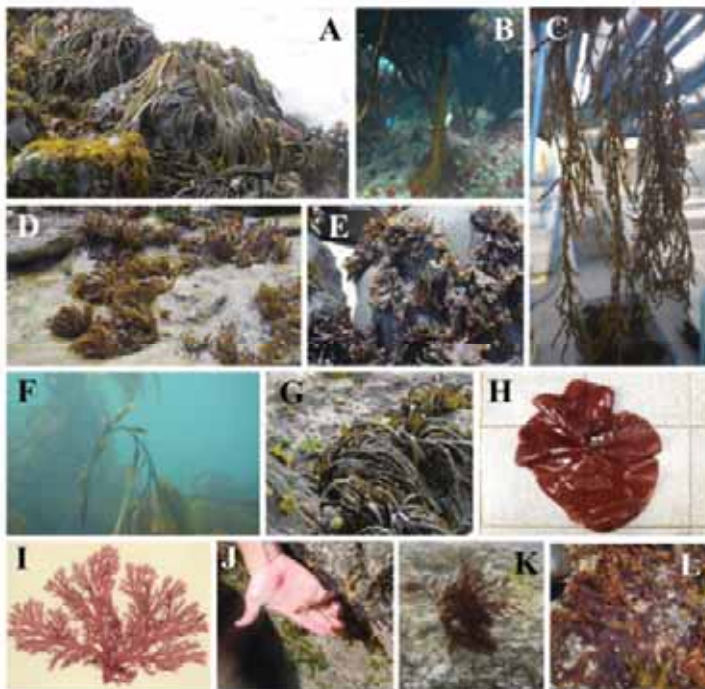
Main commercial seaweed species

Durvillaea antarctica (bull kelp, or *cochayuyo* in Spanish) and *Porphyra* (purple laver, or *luche* in Spanish) are the two seaweed species most commonly found at Chilean national markets for direct consumption. They grow along the entire Chilean shoreline in the high intertidal area (usually in the spray zone), occurring either on large rocks or boulders. They can be found in coastal markets, sold by local fishers, and in grocery and supermarket chains in inland cities and towns. *Durvillaea antarctica* landings surpassed 8 000 tonnes in 2014, a sharp rise of more than 400 percent in the past ten years. *Porphyra* landings, on the other hand, were only 132 tonnes in the same year which, nevertheless, was an increase of almost ten times in comparison to 2004. *Durvillaea antarctica* and *porphyra* fisheries are located mostly in Central Chile where approximately 75 percent of total landings originate.

Of the red algae, two species belonging to the *Gigartinales* family (and therefore valuable carragenophytes) are consumed primarily abroad as seasoning in Asian dishes.

Chondracanthus chamissoi is found in intertidal and subtidal environments along Peru and Chile (from northern Chile to Chiloé Island). This species has been harvested regularly over the last ten years, especially in Chilean Region III and Region VIII with 2 715 tonnes in 2014. It is the second most produced alga for human consumption in Chile, although this trend is declining.

Callophyllis variegata inhabits Chilean subtidals (up to 12 miles) along the entire coastline. Its production was very promising 15 years ago, with a growth rate of 300 percent annually (84 tonnes in 1999) (Sernapesca, 2006); however, following 2000, volume fell to only a few tonnes. Landings of *Callophyllis variegata* now do not exceed 1 tonne per annum.



A: *Durvillaea antarctica*. B: *Lessonia trabeculata*. C: *Gracilaria chilensis*. D: *Mazzaella laminarioides*. E: *Porphyra* sp. F: *Macrocystis pyrifera*. G: *Lessonia nigrescens*. H: *Gigartina skottsbergii*. I: *Callophyllis variegata*. J: *Chondracanthus chamissoi*. K: *Gelidium* sp. L: *Sarcothalia crispata*.
© R. Westermeier (Images A-H; L) & M.E. Ramirez (Images I-K)

The most important carragenophytes commercially exploited in Chile are red algae belonging to the *Gigartinae* family: (i) *Gigartina skottsbergii* (*luga roja* in Spanish), (ii) *Sarcothalia crispata* (*luga negra* in Spanish) and (iii) *Mazzaella laminarioides* (*luga cuchara* in Spanish). These are valuable resources, rich in Kappa II and Lambda carrageenan. *Gigartina skottsbergii* is a subtidal species (~12 miles), occurring in Chile from Niebla (40°S) to Cabo de Hornos. Previously collected in Region X and Region XI, it is now mostly harvested in Region XII (15 000 tonnes, equivalent to 55 percent of national production).

Because *Gigartina skottsbergii* began to reflect symptoms of an over-exploited species, its biomass is currently regulated by an area rotation system, with a ban imposed during the reproductive months (May to September). For a long period, *Gigartina skottsbergii* has been the key carragenophyte species exploited in Chile, and its decreasing yield has forced the industry to consider new alternatives to obtain carrageenan, such as *Sarcothalia crispata* and *Mazzaella laminarioides*.

Sarcothalia crispata, on the one hand, is an endemic species that occurs in subtidal areas from Valparaíso (33°S) to the Strait of Magellan (54°S) in Central and Southern Chile, respectively. It coexists with the giant kelp, *Macrocystis pyrifera*, *Gigartina skottsbergii* and the crust red alga, *Mesophyllum* sp. Currently, it is the most harvested carragenophyte

in Chile (34 600 tonnes), mostly extracted in Region X. *M. laminarioides*, on the other hand, is an intertidal red alga that does not exceed 5 000 tonnes per annum. Its biomass is mainly extracted from Region X (60 percent).

Agarophytes, such as *Gracilaria chilensis* and *Gelidium spp.*, also are produced on a commercial scale in Chile, used mainly as a source of agar. *Gracilaria chilensis*, known as *pelillo* or *lamella* in Spanish, is a floridophycean red alga in sheltered environments that attaches itself either to sandy and rocky substrata in the intertidal or is found in subtidal zones. *Gracilaria chilensis* is the third most farmed seaweed in the country, with landings above 45 000 tonnes in 2014, mostly in Region X. Its current production, however, is much lower in comparison with the output in the 1980s when landings easily reached 100 000 tonnes (Sernap, 1986). The dramatic drop is attributed to over-exploitation plus the appearance of new competitors for Chilean *Gracilaria* commodities.

Nevertheless, *Gracilaria chilensis* is today the most important seaweed crop cultivated in Chile, making up almost 100 percent of total biomass obtained through aquaculture. Another significant factor regarding the production of *Gracilaria chilensis* is that it is mainly planted and harvested by local fishers.

Gelidium spp. (*chasca* in Spanish) is especially important as a source of agar for microbiological purposes. They are collected by fishers, especially in Central Chile, from wave-exposed rocks. *Gelidium spp.* landings have varied in the last ten years between 135 tonnes and 700 tonnes per annum.

The important alginophytes in Chile include the kelp species, *Lessonia nigrescens*, *Lessonia trabeculata* and *Macrocystis pyrifera*. *Lessonia nigrescens* (*huir negro* or *chascón* in Spanish), from the *Lessoniaceae* family, can be found in the intertidal zone, growing on rocky platforms in wave-exposed habitats (sometimes forming belts with *Durvillaea antarctica*). *Lessonia nigrescens* complex is the most produced seaweed in Chile (430 000 tonnes), and over 90 percent of its exploitation occurs in the northern regions where factors such as weather and accessibility favour subsequent processing. *Lessonia trabeculata* (*huir palo* in Spanish) and *Macrocystis pyrifera* (*huir* in Spanish) are found along the entire Chilean coast. *Lessonia trabeculata* and *Macrocystis pyrifera* (the latter also from the *Lessoniaceae* family) are also key seaweeds for northern Chile, with landings of 60 000 tonnes and 25 000 tonnes, respectively.



A: Pilot culture of *Macrocystis pyrifera* in Dalcahue, Chiloé Island. B: Commercial facility of *Gracilaria chilensis* at Pelluhuín.

© R. Westermeier

Processing

After collecting from the wild, the fishers may apply simple processing methods and sell the seaweed to middlemen or directly to processing companies that add value to the products. A significant amount of the seaweed is exported.



A: Sundried luga roja (*Gigartina skottsbergii*) for carrageenan manufacturing in Faro Corona, Chiloé Island. B: Fresh giant kelp (*M. pyrifera*) bound for abalone facilities at Bahía Chasco, Atacama coast. C: Packages of dried *Lessonia trabeculata* to be sent to kelp processors in Bahía Salado, Atacama. D: Harvesting of subtidal *Gracilaria chilensis* by local fishermen at Maullín. © R. Westermeier (Images B - D)

Lessonia trabeculata is either used for haliotid foraging (blades) and alginate production (stipes). *Macrocystis* is mostly restricted for abalone feeding, although there are records regarding its processing for human consumption.

Marketing and trade of seaweeds and seaweed products

The first trade of harvested seaweed is made between the local fishers/aquaculturists and middlemen, paid in the so-called ‘price on the beach’ rate which corresponds to the value of the seaweed, either fresh or with minimum processing (usually only air dried for some days). Price levels are highly variable, regionally and even monthly, depending on the availability of the seaweed and buying power (both are regularly correlated). According to data reported by Sernapesca (2015), higher prices are usually seen for *Porphyra* spp. (USD 1 927 per tonne) and *Durvillaea antarctica* (USD 1 718 per tonne), since a significant part of the landings is processed almost immediately after harvesting and sold on the local market. The prices for algal raw material typically range from USD 81 and USD 646 per tonne, with the exception of *Gelidium* spp. (USD 1 540 per tonne) which is

small in size and hence difficult to harvest, in addition to its value due to its particular agar composition.

Exports

Seaweed products that have undergone some degree of processing and are of export quality sell at higher prices (Table 20). Prices for processed (dehydrated) commodities range from USD 1 305 to USD 4 472 per tonne (IFOP, 2015), often increasing up to more than ten times as in the case of *Macrocystis*. This improvement also relates to water loss which, in certain algae, easily makes up to 90 percent of the fresh composition.

Table 20. Chile: Exports of seaweeds, 2013–2016

	Weight in tonnes; value in USD thousands					
	2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value
Edible seaweed	3 522	8 663	1 107	4 162	748	4 617
Non-edible Seaweed	71 152	134 188	67 052	96 563	75 170	103 281
Agar agar	1 780	48 754	1 825	48 790	1 562	39 030
Carrageenan	4 811	72 475	5 254	73 548	5 002	59 622
Total	81 265	264 080	75 238	223 063	82 482	206 550

Source: National Customs Service (Servicio Nacional de Aduana).

As products meant for human consumption undergo a laborious, strictly-regulated food manufacturing process, their overall prices rise accordingly. There are a few exceptions, however. *Lessonia* for human consumption was the only product in 2014 that was about the same price as its dehydrated counterpart, according to the Chilean Institute for Fishery Development. The rest that was traded in that year for human consumption reached prices between USD 3 000 and USD 5 000 per tonne; the highest level was seen for *C. chamosoi*, with values of over USD 28 000 per tonne (IFOP, 2015).

Export volumes and values of carrageenan from 2011 to 2016 are listed in Annex 12. New purchasing countries appear every year, not only for the top Chilean algal goods such as carrageenan, agar and dehydrated *Lessonia* (not for human consumption) but also for products for human consumption, the volumes of which are much smaller by comparison. The top dehydrated products in 2014 were *Lessonia spp.* (60 000 tonnes), followed by *M. pyrifera*, *Durvillaea antactica* and *G. skotsbergii* (2 100 –3 300 tonnes). The main hydrocolloids were carrageenan and agars (4 781 and 1 780 tonnes, respectively), and alginates (43–264 tonnes); these were in fact, the main goods of value marketed through commercial networks in more than 50 countries. Whereas agar is mostly exported to Japan (53 percent), 60 percent of the carrageenan is sold to Denmark and the United States of America. In comparison, alginate exports are lower (USD 5 million FOB per annum), with the main destination being Japan.

In the same period, dehydrated seaweeds were the second most exported product by Chile, and their uses overseas are likely to be for hydrocolloid extraction rather than for food manufacturing. The main dehydrated product was *Lessonia spp.*, with an average annual FOB export value of over USD 83 000 000 during the 2013–2015 period, 80 percent of which was shipped to China. Other important markets for dehydrated Chilean seaweeds

in that period were Canada, Denmark, France, Japan and Norway which, altogether, amounted to 33 percent of total sales.

Imports

Chile imports some algal products, not only for colloid processing (species such as *Euchema* and *Kappaphycus*) but also for food products like *nori*, used primarily in Asian restaurants all around the country. According to 2016 FAO data (unpublished), imports of seaweed for food totalled 3 993 tonnes in 2013. Conversely, imports of algae for other purposes decreased slightly in the same period, suggesting that trade in hydrocolloid is more or less stable.

Domestic demand

Seaweed has been used as food in Chile since the first human settlements at Monteverde in the south of the country, approximately 14 000 years ago. The tradition spread gradually from the aboriginal people, particularly in coastal communities, into the cuisine of the Spanish colonists because of the easy transportation and preservation of seaweed, as well as the fact that it was a less expensive substitute for meat in periods of poverty during the nineteenth and early twentieth centuries. *Durvillaea antarctica* and *Porphyra* spp. can now be found in different varieties of salads and soups, especially in Southern Chile around Chiloé island. Some of these seaweeds are also exported for similar purposes.



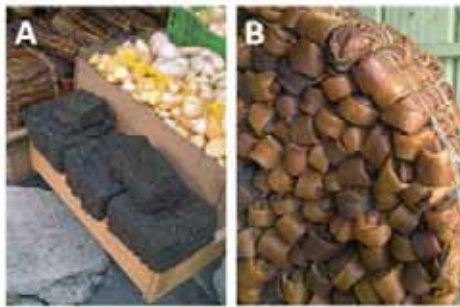
A: *Porphyra* spp. (*luche* in Spanish) and lamb *cazuela* (soup).

B: *Durvillaea antarctica* (*cochayuyo* in Spanish) salad.

In Chile, *Porphyra* spp. harvesting is mostly performed by women in the south. The fronds are sundried and, if destined for market, the seaweed are usually pre-heated in cooking pots, moulded in wooden structures and/or undergo a smoking/drying process with the help of wood stoves. The final product is a ‘pressed bread’ that is sold in coastal local markets. The handling of *Durvillaea antarctica* is, on the other hand, typically carried out by men: the biomass is sundried and manually packaged using plastic cords. The product is sold in local coastal markets and basically consists of tied, dehydrated algal bunches.

Sometimes, the biomass is bought fresh by

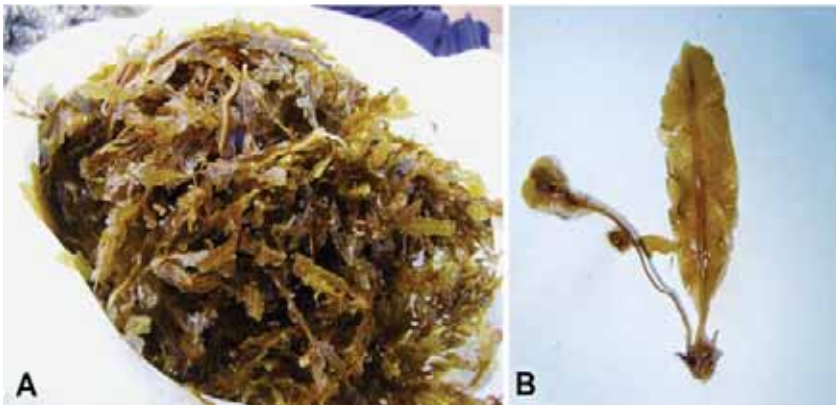
middlemen and sold to small processing facilities which inspect, chop and dry the seaweed according to buyer requirements, package it and re-sell it to local stores such as supermarkets.



Chilean seaweed products in local markets
(A: Luche 'bread'; B: tied cochayuyo).
© F. Küpper

Another example of a Chilean seaweed used for human consumption is *Dyctiopteris* sp. (*Auke* in Spanish). This brown algae has been harvested by locals on Easter Island for centuries, where it remains part of the local cuisine and

therefore is valuable. There are neither records of their landing nor of their abundance around the island, although verbal communication from inhabitants strongly suggests that its stocks are seriously endangered (Ramírez, personal communication).



Auke harvested on Easter Island (A: Full bag collected by a local Islander. B: Morphology of *Dyctiopteris* sp.)
© M.E. Ramirez

As mentioned previously, local consumption is relatively negligible in comparison to export. The most significant raw material is *Lessonia* spp., an excellent source of alginate. In addition, agar and carrageenan are produced in vast amounts in the country, using *Gracilaria chilensis* and *Gigartina/Sarcothalia* species, respectively. Several initiatives have been funded, essentially by the Chilean government, in order to expand the current use of macroalgae and, thus, the commercial opportunities for companies and local fishermen. Many of these initiatives have shown promising results, despite some having been unprofitable or technically unfeasible in Chile's current economic and/or ecological context.

3. MARKETING AND TRADE

In 2016, an estimated 1 million tonnes (product weight) of seaweed (dried and processed) were exported at an estimated value of USD 4 billion. These were imported by almost 100 markets worldwide, with Asia, Europe and North America being the main destinations for the trade.

An analysis of available published data indicates that the top 35 countries represented nearly 80 percent of global seaweed trade in 2016. Together, they imported nearly 650 000 tonnes (product weight) of dried seaweed, carrageenan and agar agar in that year, at a customs declared value of USD 2 billion (Table 21, Annexes 16a and 16b). This volume also represents 70 percent of the global production of farmed seaweed. It therefore comes as no surprise that aquaculture production of seaweed has almost doubled from 14 million tonnes in 2006 to close to 30 million tonnes in 2015, credited to its expanding usage and worldwide trade.

The top four import markets were China, the European Union, Japan and the United States of America (Table 22).

Table 21. Seaweed imports into the top thirty-five countries, 2013–2016

	Weight in tonnes; value in USD thousands					
	2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value
Edible seaweed	247 527	692 978	251 709	633 915	250 735	648 719
Non-edible seaweed	244 514	348 059	244 777	271 209	245 381	269 473
Carrageenan	115 467	913 486	111 852	891 776	110 555	759 844
Agar agar	11 738	243 316	11 771	231 958	12 052	225 624
Total	619 246	2 197 839	620 109	2 028 858	618 723	1 903 660

Source: Various sources of sources of national statistics.

The most dynamic import market is for hydrocolloid products which are traded and used widely in many countries for various applications. Dried seaweed trade for further processing, mostly for the production of agar agar, alginate and carrageenan, is dominated by developing countries as the main suppliers. Meanwhile, the trade for edible seaweed (fit for human consumption) is almost exclusively conducted in countries in the Far East, namely China, Japan, the Republic of Korea and Taiwan Province of China.

Of the total seaweed imported on the global market in 2016, 50 percent comprised dried seaweed, with edible and non-edible forms having equal share in the trade. The import demand for edible dried seaweed meant for direct consumption (e.g. *wakame*, *nori*) was stable from East Asian markets, namely Japan, the Republic of Korea Rep and Taiwan Province of China. The global trade for non-edible seaweed, however, is showing a declining trend because of its increased utilization into semi-processed and processed forms in the producing countries themselves.

Notably, China has emerged as the largest importer of edible and non-edible seaweed for further processing, influencing international market prices for dried seaweed. The European Union and the United States of America also continue to be the major markets

for dried seaweed, particularly non-edible raw materials for further processing into carrageenan and other products meant for industrial usage (Table 22). However, since China has become a major centre for reprocessing – and other developing countries such as the Philippines and Indonesia have begun developing their own agar and carrageenan processing industries – imports of dried seaweed (raw material) into traditional markets in Europe have declined.

Table 22. Top four importers of dried seaweed and hydrocolloid products, 2014–2016

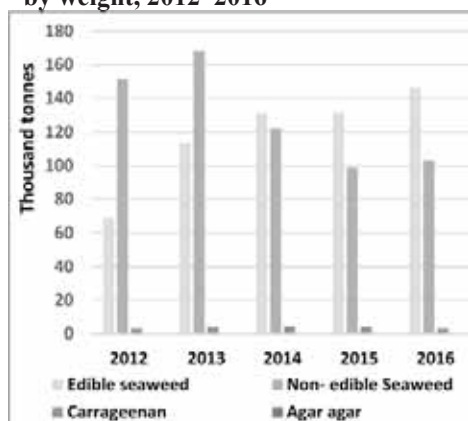
	Weight in tonnes; Value in USD					
	2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value
China	257 959	377 389	234 424	250 727	252 683	255 775
European Union	154 924	725 090	167 170	688 326	178 467	613 162
Japan	51 880	296 750	48 705	272 589	49 718	312 749
United States of America	38 102	256 442	38 278	253 227	40 861	209 143
Total	502 865	1 655 671	488 577	1 464 869	521 729	1 390 829

Source: Relevant National Statistics.

3.1 CHINA

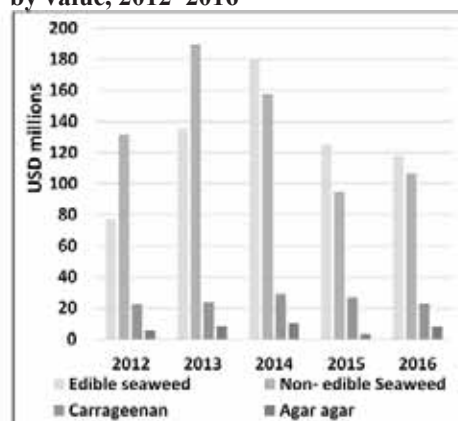
China is now the largest and most important partner in the international seaweed trade, particularly in terms of volume. During the last decade, China also emerged as the leading re-processor of hydrocolloid products processed from edible and non-edible seaweed. Imports of dried raw material reached 250 000 tonnes in 2016, 20 percent higher than the volume in 2012 (Figure 9 and Figure 10). While nearly 90 percent of edible dried seaweed imports came from Indonesia, Chile and Peru were the top suppliers of the non-edible type (Annexes 9a and 9b). Because of its dominance in the industry, China has become a price setter for trade in dried seaweed.

Figure 9. China: Imports of seaweed, by weight, 2012–2016



Source: China Customs.

Figure 10. China: Imports of seaweed, by value, 2012–2016



3.2 EUROPEAN UNION

The European Union is the second largest import market in terms of volume for seaweed, having bought nearly 180 000 tonnes of seaweed products in 2016, valued at USD 613 million. This makes the European Union the world's top seaweed import market in terms of value.

In terms of quantitative imports, non-edible dried seaweed ranked number one in 2016, with increased supplies into the European Union. The top importers were Denmark, Germany, Portugal and Spain. The same trend was seen for carrageenan, which also recorded the highest import value at USD 400 million in 2016. The main importing countries for this product were Belgium, Denmark, France, Germany, Spain and the United Kingdom.

In total, the European Union imported USD 613 million worth of dried seaweed, carrageenan and agar in 2016, slightly lower than in 2012 (Table 23). However, the volume increased by 31 percent during the 2012–2016 period as a result of more imports of SRC. For agar agar, France, Germany, Poland and Spain were the leading importing countries in the European Union.

It should be highlighted that the European Union is also an important reprocessing and re-export area, particularly for carrageenan and high quality agar agar. Intra- and extra-European Union seaweed exports were over 100 000 tonnes in 2016, the bulk of which comprised high quality processed seaweed (see Annexes 23a, 23b, 23c and 23d).

Table 23. European Union: Imports of seaweed, 2014–2016

	Weight in tonnes; value in USD thousands					
	2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value
Edible seaweed	22 953	75 813	17 175	60 726	15 184	59 662
Non-edible seaweed	65 310	74 957	89 103	79 962	88 485	69 496
Carrageenan	63 302	493 021	57 158	474 686	70 627	400 249
Agar agar	3 359	81 299	3 734	72 952	4 171	83 755
Total	154 924	725 090	167 170	688 326	178 467	613 162

Source: Eurostat.

3.3 JAPAN

Traditionally, seaweed is an important item used in Japanese cuisine; hence, one way or another, most of the imports in the country are used for human consumption. Japan is the largest importer of edible seaweed (e.g. Japanese *wakame*, *nori*) for which the average import value is USD 6–7/kg compared with USD 1/kg for products used for reprocessing in Asia or in Europe. Imports generally constitute about 35–40 percent share of the overall seaweed market in Japan. Seaweed such as *Laminaria*, *Porphyra* spp., *hizikia* (Japanese *kombu*, *nori* and *hiziki*, respectively) are all marketed in dried form, while *Undaria* spp (Japanese *wakame*) is marketed in boiled and salted forms.

During the 2012–2016 period, annual imports of seaweed into Japan ranged around 50 000 to 55 000 tonnes, valued at USD 300 million to USD 600 million (Table 24,

Figure 11 and Figure 12). Chile, China and the Republic of Korea have been the key suppliers of edible seaweed to the market (see Annexes 22a-1, 22a-2, 22b, 22c, 22d-1 and 22d-2).

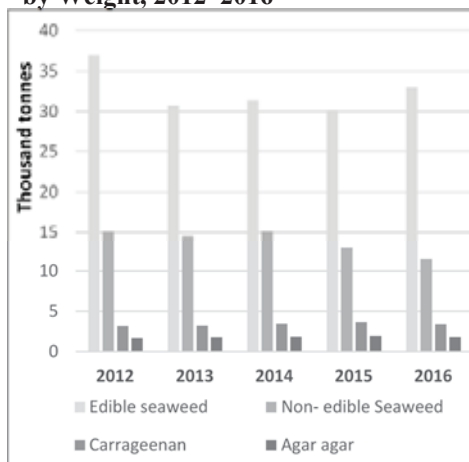
Chile, China, the Republic of Korea and Morocco are the top suppliers of agar, while several Southeast Asian countries, namely Indonesia, the Philippines and Thailand, supplied carrageenan, together with Denmark and the United States of America. The high-quality products originated from the latter two sources.

Table 24. Japan: Imports of seaweed, 2013–2016

	Weight in tonnes; value in USD thousands							
	2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Edible seaweed	30 776	177 688	31 427	179 062	30 182	164 276	32 989	210 207
Non-edible seaweed	14 548	36 058	15 141	36 630	12 903	28 089	11 497	27 605
Carrageenan	3 233	27 505	3 462	31 185	3 665	30 421	3 419	29 490
Agar agar	1 785	46 519	1 850	49 873	1 955	49 803	1 813	45 447
Total	50 342	287 770	51 880	296 750	48 705	272 589	49 718	312 749

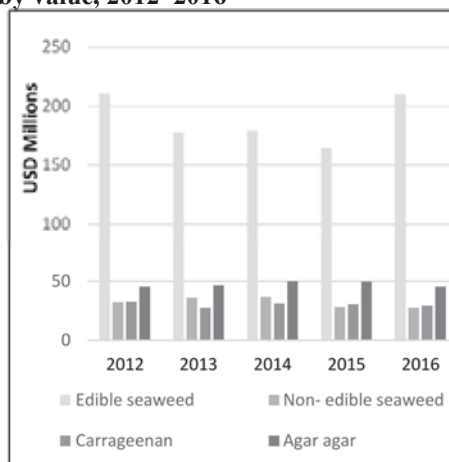
Source: Ministry of Finance, Japan.

Figure 11. Japan: Imports of seaweed, by Weight, 2012–2016



Source: Ministry of Finance, Japan.

Figure 12. Japan: Imports of seaweed, by value, 2012–2016



3.4 UNITED STATES OF AMERICA

The United States of America remains an important outlet for semi-processed and processed seaweed. The reprocessing industry there, however, also imports non-edible seaweed for the manufacture of non-food quality products such as alginic acid (Table 25 and Figures 13 and 14).

Carrageenan is the main component in U.S. seaweed imports. When the United States of America lifted its ban on Philippines Natural Grade (PNG) carrageenan in the late 1980s, imports of the product doubled within a few years, to approximately 10 000 tonnes annually. It has remained at that level in recent years, possibly indicating market saturation. Over the years, Chile and the Philippines have retained their number one and number two status as suppliers, while Indonesia and Malaysia have increased their overall supplies of carrageenan to the United States of America. Some reports indicate that U.S. carrageenan consumption is about 60 percent import dependent.

Imports of agar from the United States of America also have remained stable, at around 1 300–1 500 tonnes annually (Annex 21). Supplies were dominated by Chile, China, Morocco and Spain.

Table 25. United States of America: Imports of seaweed, 2013–2016

	Weight in tonnes; value in USD thousands					
	2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value
Edible seaweed	7 180	60 670	10 695	72 628	8 560	55 883
Non- edible seaweed	18 030	46 698	14 826	36 400	20 959	38 481
Carrageenan	11 475	114 695	11 192	105 699	9 959	82 830
Agar agar	14 17	34 379	1 565	38 500	1 383	31 949
Total	38 102	256 442	38 278	253 227	40 861	209 143

Sources: U.S. Department of Customs and Border Protection; U.S. Census Bureau.

Figure 13. United States of America: Imports of seaweed, by weight, 2012–2016

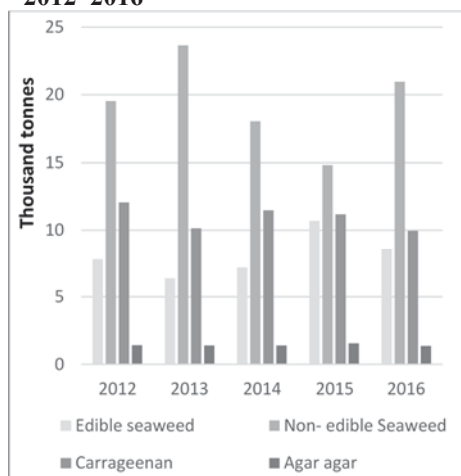
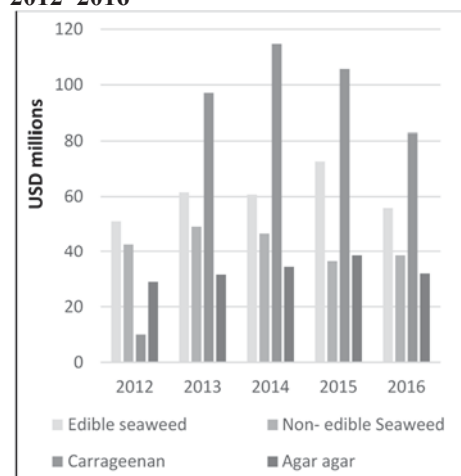


Figure 14. United States of America: Imports of seaweed, by value, 2012–2016



Sources: U.S. Department of Customs and Border Protection; U.S. Census Bureau.

3.5 MARKET TRENDS FOR DIFFERENT PRODUCT TYPES

For the last few years, China has dominated the global seaweed market as an importer of raw material and exporter of semi-processed and processed products. There is a growing focus, however, on adding more value in other countries in Asia and Latin America to match the rising demand for food-grade carrageenan and agar agar, particularly from the developing markets. Meanwhile, the usage of seaweed as a binder and thickener has increased significantly in the food processing industry in Asia, Latin America and the Middle East.

In Southeast Asia, Malaysia and Thailand are net importers of semi-processed and processed seaweed. Furthermore, domestic demand for such products by the food processing industries in Indonesia is on the rise. Imports of seaweed-based products, such as jelly among others, also are growing in other large markets in South Asia (Bangladesh, India and Pakistan) where consumer demand for ready meals is increasing. In Latin America, imports of hydrocolloids have increased in Argentina, Brazil, Mexico and various other countries for usage in the food processing industry.

Figure 15. World: Importers of edible seaweed, 2012–2016

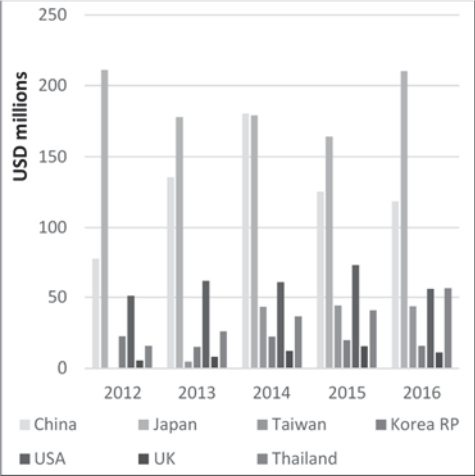
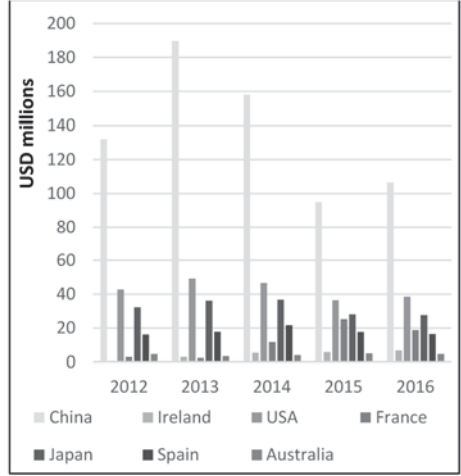
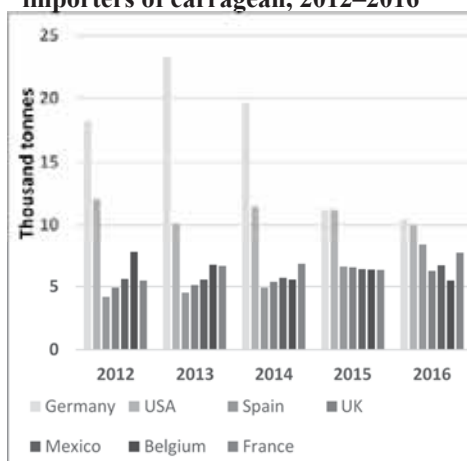


Figure 16. World: Importers of non-edible seaweed, 2012–2016



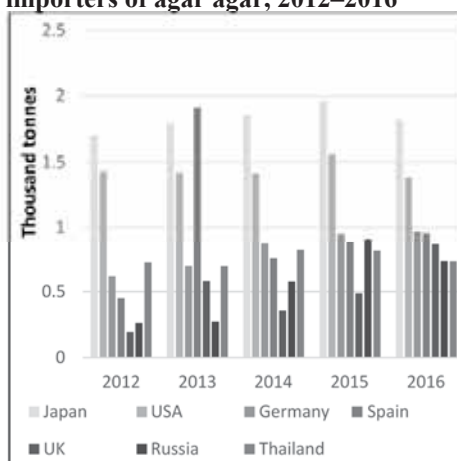
Source: National Statistics.

Figure 17. World: Top seven importers of carrageenan, 2012–2016



Source: National Statistics.

Figure 18. World: Top seven importers of agar agar, 2012–2016



3.6 SEAWEED EXPORT TRENDS

In 2016, the total reported exports of seaweed from the top five suppliers (Indonesia, the EU, Chile, China and the Philippines) had a combined 30-percent share in global export volume. In terms of export value, however, the top suppliers were China, the European Union, Chile and the Philippines due to higher-value carrageenan and agar agar, among others. Overall supplies of seaweed from these countries to the international market increased moderately during the 2012–2016 period, except from the Philippines (Table 26, Figure 19 and Figure 20).

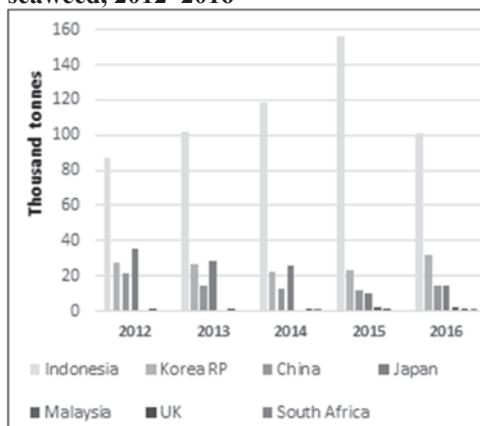
The lion's share of Indonesia's seaweed exports consisted of dried seaweed, which had a much lower export value (USD 800–USD 1 000/tonne) compared with semi-processed carrageenan (USD 8 000–USD 10 000/tonne) and agar agar.

Table 26. World: Top exporters of seaweed, 2012–2016

	Weight in tonnes				
	2012	2013	2014	2015	2016
Indonesia	174 836	182 446	206 572	212 245	188 760
European Union	82 171	95 411	103 447	101 546	101 594
Chile	77 990	88 409	81 265	75 238	82 482
China	69 239	64 284	68 135	70 828	78 681
Philippines, The	50 089	60 568	45 675	42 093	42 866
Total	279 489	308 672	298 522	289 705	305 623

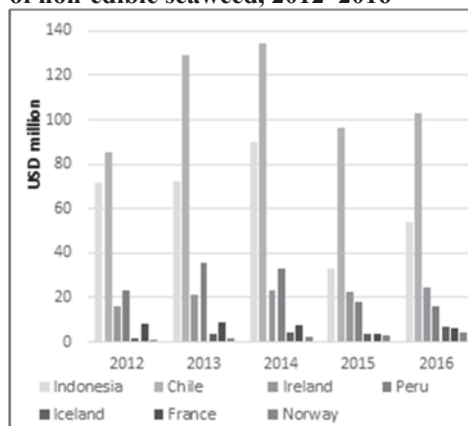
Source: National Statistics.

Figure 19. Top seven exporters of edible seaweed, 2012–2016



Source: National Statistics.

Figure 20. World: Top seven exporters of non-edible seaweed, 2012–2016



For edible dried seaweed, China, Indonesia, Japan and the Republic of Korea were the main suppliers to the global market in 2016, taking about 75 percent share in terms of the quantity. In terms of value, however, the Republic of Korea was the largest exporter, mainly selling dried seaweed for direct human consumption to the Japanese market, largely the *Undaria* and *Hizikia* species.

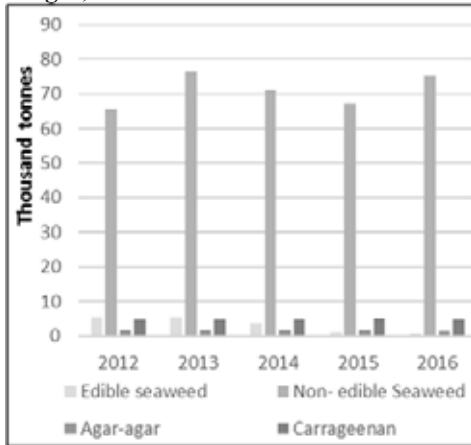
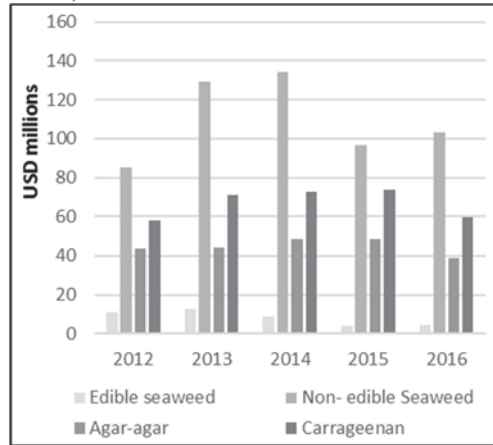
Indonesia: Seaweed exports from Indonesia are dominated by edible and non-edible raw dried products (Annexes 13 and 14), for which China is the principal market. The other key markets for these categories are Chile, Malaysia and the Philippines, which import dried seaweed for processing carrageenan and agar agar. For processed seaweed, the export volume of carrageenan has levelled off to around 5 000 tonnes annually during the 2012–2016 period, with some fluctuations. The export markets in that period for Indonesian carrageenan were the European Union, Japan and the United States of America. Exports have also increased in recent years to Australia, Brazil and the Russian Federation.

Chile: In terms of volume and value, non-edible dried seaweed – mostly *Gracilaria* – was the main export item from Chile. Some 80 percent of this product group went to China in 2016, continuing the increasing trend during the 2012–2016 period (Figures 21 and 22). Exports of carrageenan from Chile peaked in 2015 (Table 27) but declined in 2016. The main markets were the European Union and the United States of America. There were, however, increasing exports to the Latin American markets of Argentina, Brazil, Ecuador, Mexico and Peru. Meanwhile, Chilean exports of agar dwindled.

Table 27. Chile: Exports of seaweed, 2014–2016

	Weight in tonnes; value in USD thousands					
	2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value
Edible seaweed	3 522	8 663	1 107	4 162	748	4 617
Non-edible seaweed	71 152	13 4188	67 052	96 563	75 170	103 281
Agar agar	1 780	48 754	1 825	48 790	1 562	39 030
Carrageenan	4 811	72 475	5 254	73 548	5 002	59 622
Total	81 265	264 080	75 238	223 063	82 482	206 550

Source: National Customs Service (Servicio Nacional de Aduana).

Figure 21. Chile: Exports of seaweed, by weight, 2012–2016**Figure 22. Chile: Exports of seaweed, by value, 2012–2016**

Source: National Customs Service (Servicio Nacional de Aduana).

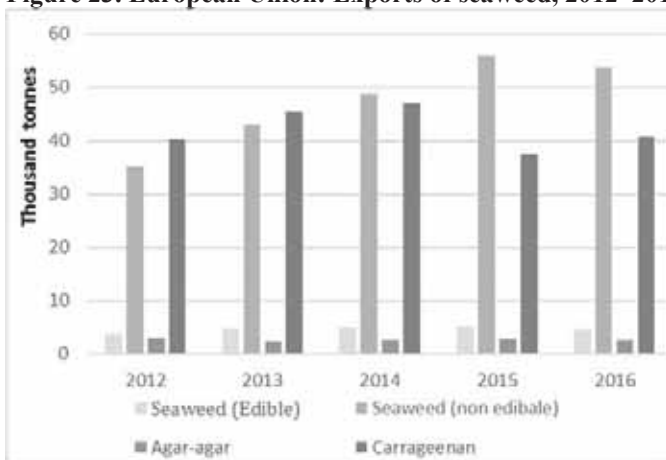
European Union: Non-edible dried seaweed, carrageenan and agar agar are the main seaweed exports from the European Union (Table 28). France and Ireland were the key exporters of non-edible seaweed, with smaller amounts from Germany, Portugal and Spain (Annex 14). With regard to carrageenan, France, Germany, the Netherlands and Spain are the main exporting countries from the European Union. From about 2010, however, exports increased only from Spain but declined from the others. For agar agar, the leading exporters are France, Germany and Spain and, notably, French agar agar is the most expensive because of its high grade.

Table 28. EU: Exports of seaweed and seaweed-based products, 2012–2016

	Weight in tonnes				
	2012	2013	2014	2015	2016
Seaweed (edible)	3 733	4 691	5 041	5 219	4 607
Seaweed (not edible)	35 138	42 910	48 833	55 974	53 723
Agar agar	2 897	2 431	2 634	2 766	2 462
Carrageenan	40 403	45 379	46 939	37 587	40 802
Total	82 171	95 411	103 447	101 546	101 594

Source: Eurostat.

Figure 23. European Union: Exports of seaweed, 2012–2016



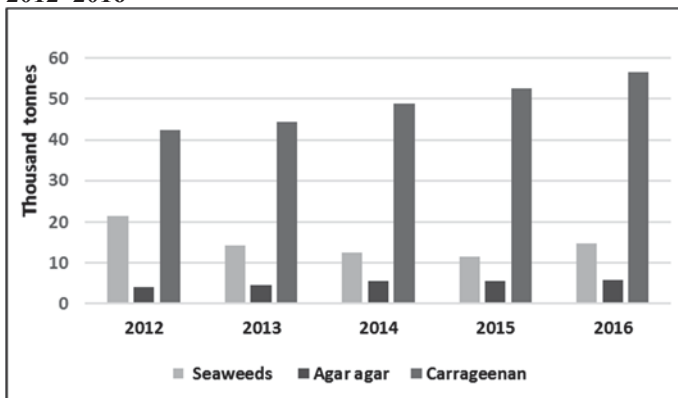
Source: Eurostat.

China: A major producer and exporter of processed seaweed, China exported USD 500 million worth of seaweed in 2016. Exports of dried seaweed are relatively low and consisted of higher value *wakame* and *nori*, among others, for direct consumption. Japan, the Russia Federation and Southeast Asia were the main markets that same year.

Carrageenan, the biggest component of China's seaweed exports, increased significantly from 43 000 tonnes in 2012 to 56 600 tonnes in 2016, valued at USD 360 million (Annexes 8d and 8e, and Figure 24). The main export markets were the Asia, the European Union and the United States of America.

Agar agar exports also increased, from 4 000 tonnes in 2012 to nearly 6 000 tonnes in 2016, for which the main markets were Germany, Italy and Spain within the European Union, as well as Malaysia, the Russian Federation and Thailand. Exports also increased to many other markets in the developing world.

Figure 24. China: Exports of dried edible seaweed and other processed products, 2012–2016



Source: China Customs.

The Philippines: The seaweed export trade in the Philippines consists more of semi-processed and processed products. The country also exports a small quantity of dried seaweed.

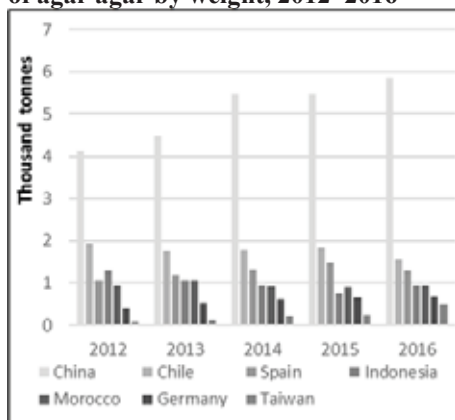
In Asia, the Philippines is the second largest supplier/exporter of semi-processed and processed carrageenan, following China. Exports of carrageenan increased by 33 percent during the 2012–2016 period, valued at USD 190 million in 2016 (Annex 11c). The United States of America has been its main market for carrageenan, followed by the Brazil, European Union, Indonesia, Japan, Mexico and Thailand. Exports have also increased to new markets, namely Argentina, Australia, Brazil, Indonesia and the Russian Federation.

Exports of dried seaweed are mainly edible varieties, and have declined over the past years. In 2016, the volume was relatively small, at 11 000 tonnes (Annex 11a).

3.7 PROCESSED SEAWEED IN INTERNATIONAL TRADE

Three types of seaweed are usually sold on the international market, namely (i) edible seaweed products that are directly consumed as food; (ii) dried seaweed as raw material for further processing; and (iii) the hydrocolloids agar/alginate and carrageenan. The market dynamics mostly are due to hydrocolloid products, namely carrageenan and agar agar, which are traded and used widely in many countries for food and non-food usage.

Figure 25. World: Top seven exporters of agar agar by weight, 2012–2016



Source: National Statistics.

Figure 26. World: Top seven exporters of agar agar by value, 2012–2016

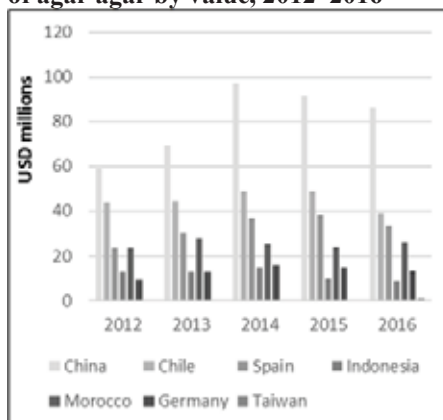
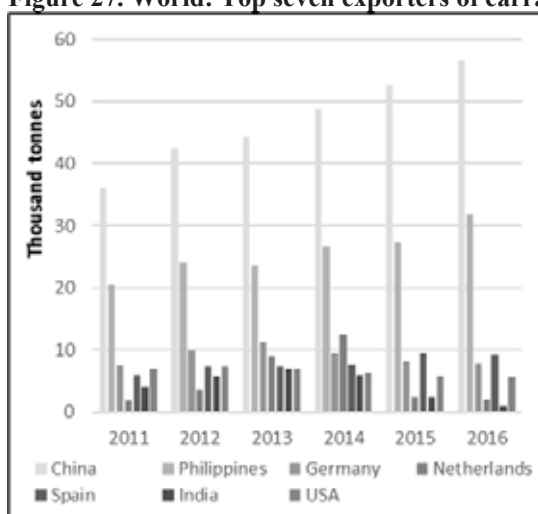


Figure 27. World: Top seven exporters of carrageenan, 2011–2016



Source: National Statistics.

3.8 PRICE TRENDS ON THE INTERNATIONAL MARKET

In general, seaweed prices vary between different species, product forms, quality, country of origin to name a few. Price fluctuations also take place from time to time due to supply and demand.

With regard to dried seaweed, China – as the single largest importer – dictates the international market price for the carrageenophytes *Kappaphycus alvarezii* and *E. deliticutatum* (*E. spinosum*) which are grown in the Asia and the Pacific region. The price chart below (Table 29) shows the lower import price range for dried Southeast Asian seaweed (Indonesia, Malaysia, the Philippines), compared to products from Chile in Latin America.

Table 29. China: Average import price trends for edible dried seaweed (HS 121221) by country of origin, January-July, 2015–2016

Exporting country	USD/tonne		
	2015	2016	2017
Indonesia	1 039	716	916
Philippines	956	801	906
Malaysia	1 236	739	977
Japan	3 307	5 404	2 965
Chile	3 179	2 043	3 683
Taiwan Province of China	3 938	7 657	7 576

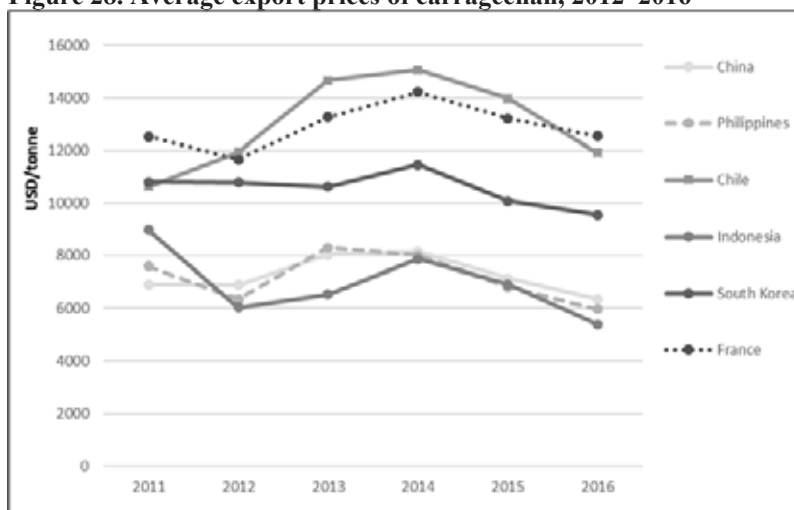
Source: China Customs.

The price of carrageenophytes, especially *E. spinosum*, is rather sensitive to supply fluctuations. Prices tend to be cyclical; as demand increases, farmers ramp up production, creating an over-supply that subsequently forces a drastic drop in prices. When prices are low, farmers tend to abandon their farms, thus decreasing supply and moving prices up

again. Similarly, for processed seaweed, there is a wide range of hydrocolloid prices that are determined by many factors, such as quality, grade type, brand name, country of origin, physical product characteristics to name a few.

Figure 28 depicts the much higher export prices of carrageenan of Chilean and French origin. These are most likely linked to high value species and product quality (particularly French products). Products of Asian origin (i.e. China, Indonesia and the Philippines) tend to be in the same price range.

Figure 28. Average export prices of carrageenan, 2012–2016



Source: National Statistics.

3.9 MARKET OUTLOOK

The global production of seaweed has increased significantly over the last decade in response to its wider usage in the food and non-food sectors. Demand for fresh and preserved forms, including dried seaweed for direct consumption, is largely limited to the East Asian markets and wherever Japanese cuisine exists elsewhere in the world. However, hydrocolloid products (carrageenan, agar agar and alginic acid) have had a further-reaching impact in the global consumer market in terms of food and non-food.

Of the processed seaweed products, carrageenan is the most widely used and has many purposes. Its current international trade is estimated to be 120 000 tonnes. While the large markets at present are the European Union and the United States of America, demand for carrageenan is growing, particularly in non-producing countries (see Annexes 20a and 20b). This trend is likely to extend into other developing countries. The market prospects for carrageenan are favourable, with positive growth expected in many new markets and market segments.

3.10 TARGETING THE HALAL MARKET

A study conducted by the Dubai Chamber of Commerce and Industry indicates that the global halal market is projected to grow to USD 1.6 trillion by 2018 (DCCI, 2014). Of this amount, the halal food trade alone contributes USD 630 billion. Catering to the religious obligations and preferences of Muslims has become a big business, particularly with regard to the food, clothing and tourism sectors, and in no other region is this more obvious than the Asia and the Pacific region. Even countries which are not classified as Muslim nations – notably Japan, the Republic of Korea, the Philippines, Singapore and Thailand – are encouraging their business sectors to acquire that all-important, universally accepted halal certification for food products in order to gain their share of the huge halal global market. Interestingly, Malaysia and Indonesia are the only Muslim countries (ranking eighth and ninth, respectively) in the top ten of the world's leading halal markets.

Government statistics indicate that visitors to Thailand from Muslim countries in Asia and the Middle East have more than doubled between 2006 (2.6 million) and 2016 (approximately 6 million). In addition to catering for tourists, Thailand has an established domestic market within its sizeable Muslim population in the southern part of the country. As Thailand ranks ninth in world halal food exports, it can be safely assumed that most of these products are shipped to other countries. This trend is likely to continue, aided by support from the Ministry of Industry, which budgeted THB 180 million (USD 5.1 million) to promote exports of halal products in fiscal year 2016.

Thailand's Ministry of Industry also has announced that it will spearhead development plans for halal products from small and medium enterprises on a "One Tambon, One Product" basis, with the objective of pushing Thailand's ranking to one of the world's top five halal exporters by 2020. Some THB 120 billion (USD 3.4 million) also has been allocated for the National Food Institute of Thailand and THB 60 billion (USD 1.7 billion) to the country's Department of Industrial Promotion. The Central Islamic Committee of Thailand will also receive funds to expedite certification operations for halal food products.



*Crispy Seaweed Spicy Flavour;
Tao Kae Noi Brand carries a halal label.*

According to the National Food Institute, about half of the halal exports from Thailand consists of rice, followed by sugar (approximately 20 percent); how much of the remainder comprises seaweed and other algae is not definitive. A memorandum of understanding has been signed, however, between the institute and Halal Development Foundation Japan, where the former will assist Japanese investors to gain the official halal trademark from the Central Islamic Committee of Thailand. The result will be food from Japan, including seaweed, being accessible on the global halal market.

Singapore is worth mentioning since it is an interesting example of innovation in services. As the island state lacks space to build huge facilities to manufacture foods, it offers what some other nations may need: halal consultancy (i.e. education and awareness on how to

produce, process and market products for Muslim countries). There are more than ten active halal consultancy firms that assist companies to attain halal certification locally and globally.

In 2014, the halal certifying body in Singapore, Majlis Ugama Islam Singapura, established a company called Warees Halal Ltd. in 2014 as its executive arm. Companies from Japan and the Republic of Korea have attended the seminars organized by Warees Halal Ltd. According to the 2014 annual report of Singapore's certifying body, some SGD 4 million (USD 2.95 million) in income was derived from halal certification in Singapore in that year.

In the quest to comply with halal requirements, businesses look for plant alternatives for animal proteins and nutrients. Apart from seaweed as a direct food source, hydrocolloids from seaweed are ideally suited as substitutes for the animal-origin hydrocolloids gelatine, caseinate, whey protein, soy protein, egg white protein and chitosan. It must be noted also that halal food complies with the need for kosher food for Jewish communities, as well as the food standard requirements of the U.S. Food and Drug Administration and Codex Alimentarius Commission and are thus acceptable for all, Muslims or otherwise.

3.11 GLOBAL CERTIFICATION

In addition to products for the halal market, consumers (particularly in the developed world) increasingly seek evidence that production and processing has been conducted in a sustainable manner, from the raw material being contaminant-free and safe to eat to the final product. Products certified in this manner are expected to be sold at higher prices and to line the shelves in organic sections of major supermarkets.

In response to the call for a globally accepted standard that rewards sustainability and safety, certification schemes are being developed, such as the Seaweed Standard of the joint Marine Stewardship Council and Aquaculture Stewardship Council, planned for release in its introductory phase in October 2017.

This initial phase will be open for farmed and wild seaweed operations that meet the following criteria: sustainable populations, minimizing environmental impacts, effective management, social responsibility and community relations. Certificates awarded during this phase will be valid for three years. The Seaweed Standard conforms to international norms of good conduct, including FAO Guidelines for Ecolabelling of Fish and Fishery Products from Marine Capture Fisheries as well as ISEAL Codes of Good Practice.

4. PROCESSING AND UTILIZATION

Seaweed utilization, particularly in Asia, dates back more than 2 500 years. In 600 BC, the Chinese philosopher, Sze Teu, wrote that, "Some algae are a delicacy fit for the most honored guests, even for the King himself." Conversely, in a few other countries with a similarly long tradition of utilizing seaweed, such as Ireland, seaweed (Irish moss) was at one time (but no longer so) regarded as food for the indigent.

Today, China, Japan and the Republic of Korea are the world's largest consumers of seaweed, commonly used as *nori* sheets to wrap sushi; *kombu*, a soup stock ingredient; and *wakame* for soups and salads. Seaweed – partly because of the increasing popularity of sushi – is being also consumed on a large scale in the Europe. South America and the United States of America.



Dried seaweed lines the shelves of Japanese-themed outlets in many Asian supermarkets, in this case in Malaysia.

© Fatima Ferdouse

The health benefits of seaweed, due to its high complement of iodine, calcium, copper, iron, Vitamin C, Vitamin B12, Vitamin K, and protein, are an additional reason for its rising consumption. Important compounds present in seaweed include fucoidan and glutamate, which improve heart health and brain function. It is often pointed out that the Japanese, who eat seaweed regularly, have one of the highest life expectancies in the world.

4.1 SEAWEED AS A COMPONENT IN MANY INDUSTRIES

Seaweed is found in many more products than commonly thought, either consumed directly or processed into food products (primarily in the East Asian countries of China, Japan and the Republic of Korea). Taking *Gracilaria* sp. as an example, in Asia, the major consumers are Indonesia, Japan (local name of *ogonori* or *ogo*), Malaysia, the Philippines (local name of *gulaman*), Thailand and Viet Nam. In the West Indies it is sold in markets as sea moss, reputed to have aphrodisiac properties, and is also used as a base for a non-alcoholic drink. In Hawaii, where *Gracilaria* is eaten as part of salad dishes, it is farmed in cages in coastal waters and fertilized by shrimp farm effluent. *Gracilaria* is also a common macroalgae for sale in the aquarium trade.

Carrageenan from red seaweed and algin or alginates from brown seaweed are used as thickening agents in confectionaries, bakery products, salad dressings, ice creams, sweets and desserts (e.g. puddings, chewing gum, jams, jellies), dairy products such as chocolate milk, beverage mixes and in processed meats, sausages and fish, as well as in clarifying of beers and wines.



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Carrageenan and alginates are used also in pharmaceuticals as binders, stabilisers, emulsifiers, and for creating moulds in dentistry. Alginates are further used in oral medications such as cough medicine and in the care of wounds.

4.2 CARRAGEENAN

The main algae for carrageenan extraction in the 1970s used to be *Chondrus* (Irish moss), which was harvested from the wild in Canada. The rising demand for carrageenan, however, has resulted in an expansion of *Kappaphycus alvarezii* (*cottonii*) and *Eucheuma denticulatum* (*spinosum*) farming in Fiji, Indonesia, Kenya, Kiribati, Madagascar, Malaysia, the Philippines and Tanzania. Other carrageenan genera are harvested from the wild, such as *Chondrus*, *Furcellaria*, *Gigartina*, *Sarcothalia*, *Mazzaella*, *Iridaea*, *Mastocarpus* and *Tichocarpus*, mainly sourced from Argentina, Canada, Chile, Denmark, France, Japan, the Democratic People's Republic of Korea, the Republic of Korea, Mexico, Morocco, Portugal, Russian Federation, Spain and the United States of America.



In Southeast Asia, carrageenan is used as a binder for items such as burgers.

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The bulk of the carrageenan is refined. Processing of the raw material takes place mainly in the Denmark, France, the Philippines and the United States of America to produce three major types: alcohol processed refined carrageenans; potassium chloride processed RCs; and SRC, also referred to as PNG (Philippine Natural Grade) or PES (Processed *Eucheuma* Seaweed). The latter has, only in recent years, been approved for food applications. It is recognized differently in European Union and U.S. legislation, the former in the Code of Federal Regulations and the latter in Annex I of the European Parliament and Council Directive 95/2/EC of 20 February 1995 on food additives. Under the Codex Alimentarius, carrageenan and Processed *Eucheuma* Seaweed have been given an Acceptable Daily Intake of “not specified” by the Joint FAO/WHO Expert Committee on Food Additives.

An important point to note is that SRC, presently utilized primarily in Asia, is increasingly in demand in Europe, where technological development can be said to be swifter than in Asia. CyberColloids Ltd., a research and product development group, reported that between 2006 and 2011, most of the new products containing SRC were launched in Europe and dominated the carrageenan market.

4.3 OTHER USES OF SEAWEED

Thalassotherapy has gained popularity in the beauty and wellness industry. Extracts of seaweed are used in diet pills (they tend to expand in the stomach, creating a feeling of fullness); or they may be part of skin care packages (facial masks, bath salts, massages, gels, shampoos, cleansers, shaving creams) or cosmetics, often mixed with aromatic oils. Some wellness centres offer full-body seaweed wraps, followed by a warming of the body with infrared lamps, claimed to improve blood circulation and help relieve rheumatic pain and remove cellulite.

In other industrial sectors, seaweed is used in soil fertilizers because of its rich plant nutrients (e.g. potassium, nitrogen and phosphorus). Algins are found in paints and pigments, paper, cardboard, textile printing, personal lubricants, as a substrate in bacterial culture, and in explosives, pesticides and fire retardants. Research is also ongoing into biofuel production using seaweed.

Seaweed is also a filtering agent due to its ability (during photosynthesis) to rapidly consume ammonia, ammonium nitrate, nitrite, phosphate, iron and copper, as well as carbon dioxide, thus filtering these nutrients out of water bodies. FAO (2015) estimates that in 2014, 124 million tons of nitrogen were used globally as fertilizer, of which between 15 percent and 30 percent ended up in coastal waters. Particularly useful is the fact that the nutrient-laden algae (especially macroalgae as opposed to microalgae) can simply be pulled out and disposed of, if necessary. This natural filtering process can be replicated in man-made environments using seaweed filters such as algae scrubbers.



September 2017, Zanzibar – FAO Director-General, José Graziano da Silva, inspecting a variety of products made from seaweed during his visit to Paje Beach.

©FAO/Kevin Midigo

Seaweed also forms a part of the diet for farmed fish and fishery species – such as kelp (*Ecklonia*) for abalone feed in South Africa – and animal feeds. In addition, studies are underway on whether adding seaweed to livestock feed will substantially reduce methane emissions from cattle.

5. CONCLUSIONS AND OUTLOOK

For centuries, seaweed has been utilized throughout the world – in the earliest times, solely as a food source for coastal communities. Today, the global seaweed industry is worth more than USD 6 billion per annum (approximately 12 million tonnes in volume), of which some 85 percent comprises food products directly or indirectly used for human consumption.

As wild harvests decline due to over-exploitation, the aquaculture sector has expanded exponentially. In 2015, of the total global seaweed production of 30.4 million tonnes, 29.4 million tonnes originated from the culture sector. Producing nations are aware of the need to ensure the sector's long-term economic and environmental development, in addition to continuing research in identifying fast growing, high yielding and disease-resistant varieties.

At the domestic level, seaweed is seen as not only a source of nutritious food for populations, but also its culture and trade bring about the considerable enhancement of socio-economic livelihoods. Seaweed-derived extracts (carrageenan, agar, and alginates) are also a major source of trade income, making up almost 40 percent of the world's hydrocolloid market. Continuity in the availability of high-quality supplies is therefore essential, and it can be only achieved through aquaculture.

The global seaweed market is experiencing steady growth, buoyed by the increasing demand for products in the 'fit/not fit for human consumption' categories. In 2016, seaweed and seaweed products were traded at an estimated value of USD 10.6 million. Assuming an annual growth rate of about 10 percent, the total value could be as high as USD 26 million by 2025. Of the red, brown and green commercially important seaweed species, red varieties comprise slightly more than half of the global value. This trend is likely to continue due to their rising use in the food industry in the most significant growth centre, Asia, as well as across the world.

By region, the Asia and the Pacific region (China, Japan and the Republic of Korea) is the largest market, absorbing approximately 60 percent of seaweed and hydrocolloids supplies, followed by Europe and the Americas. The latter two regions are experiencing a rise in seaweed consumption due to its reputation as a healthy food as well as the increasing popularity of Japanese cuisine.

In terms of processing and utilizing products not directly consumed as food, seaweed is much more present than is generally recognized. Carrageenan from red seaweed, as well as algin or alginates from brown seaweed, are used in the thickening/gelling of food products; processing of meats, sausages and fish; clarifying alcohol; pharmaceuticals and dentistry; the health and beauty industries; soil fertilizers; textile printing; bacterial culture as a substrate; water filtration; and livestock and fishery diets.

Seaweed and other algae are an essential source of nutritious food for human consumption; provides jobs for coastal communities and growers; and are essential components in a significantly wide range of food and non-food commercial industries. Their presence is so ubiquitous in many familiar products in the retail and commercial sectors that it often goes unrecognized until labels are examined.

5.1 PRODUCTION AND SUSTAINABILITY

The output of seaweed and other algae from the culture sector has increased sharply over the last decade (2006–2016). This trend is likely to continue as wild harvests stagnate or even decline due to over-exploitation, changing environmental conditions, water pollution and, most of all, market demand for seaweed as food as well as for its extracts used in commercial industries. Red seaweed has the highest application in the food and commercial sectors, making it the preferred selection for aquaculture over the brown and green varieties.

As a result of the overwhelming importance of aquaculture, the leading producing nations are focusing on ensuring the sector's long-term economic and environmental development, in addition to continuing research in identifying fast-growing, high-yielding, disease-resistant varieties of seaweed. More countries should make efforts to ensure that genetic biodiversity is preserved, potentially through the establishment of seaweed gene banks.

With regard to wild seaweed, harvesters should be made aware of the importance of ensuring sustainability; for example, they could cut or prune seaweed rather than pull it out from natural beds. Also essential is make certain that the wild seaweed is contaminant-free – an area where relevant governing authorities must implement effective coastal zone management policies.

In countries where growers are members of a group or organization, governments are more able to collectively manage and improve culture and wild harvest techniques and output, so that the relevant socio-economic benefits are not lost and that the quality of the fresh or processed seaweed is maintained. There are various approaches that can be promoted, one of which is to encourage growers to examine IMTA as a means of raising incomes in limited culture areas, manpower, and finances. Successful IMTA projects involving seaweed have existed for many years in Brazil, China and the Republic of Korea.

5.2 SEAWEED FOR HUMAN CONSUMPTION

In the short term, China is expected to remain the world's leading seaweed producer, a significant portion of which goes primarily to meet the needs for human consumption and the food industry (carrageenan and agar). The rising demand for seaweed snacks and the growing global popularity of Japanese cuisine (particularly sushi) are two major factors that will continue to drive market demand for seaweed as food. Underlying this trend is the fact that seaweed is recognized as a powerhouse of vitamins and minerals that are highly beneficial to health.

Product diversification is essential when creating items to appeal to various demographics and cultures. One only has to look at the innovative products (including snack foods and ready-to-eat meals) that are being manufactured in the European Union, several Southeast Asian countries (China, Japan, the Republic of Korea and Thailand) and the United States of America; the various brands and formulations to suit regional tastes; and the reach out to a wider global market. Flavoured tidbits, noodles, health drinks, crackers, cookies,

sweets, condiments and prepared salads are some of the products constantly being invented and re-invented.

Among the key criteria in relation to the ‘seaweed for human consumption’ sector are to ensure that products are certified as sustainable and organic and that they preferably carry a halal logo. With regard to the former, globally accepted certification schemes, such as that of the Marine Stewardship Council, are present. In terms of the halal market, several countries in the Asia and the Pacific region are forging ahead with certification and the manufacture of products to appeal to not only the huge Muslim market, but also beyond that. In terms of global sales, products such as these would fetch premium prices and attract greater demand in the respective target markets. Certification would add value to the products in terms of acceptability and sales. One can expect that the global seaweed industry will continue to grow with these factors in mind.

5.3 SEAWEED EXTRACTS

Apart from seaweed for human consumption, its extracts (carrageenan, agar agar, and alginates) contribute about 40 percent to the global hydrocolloid market. Indonesia, the second biggest producer, focuses on species (e.g. *Eucheuma* spp., *Kappaphycus* spp. and *Gracilaria* spp.) from which carrageenan and agar agar are extracted. Currently, Indonesia and the Philippines sell the raw material to other countries (China, Japan and Norway) for processing into these extracts, although this may change in the future as the Government of Indonesia steps up plans to revitalize the seaweed production and processing sectors in Indonesia.

Carrageenan is especially in demand as a gelling agent for use in the food industry and, together with agar agar and alginates, these extracts are in widespread application as an additive in the food and non-food industries (e.g. medicine, research, pharmaceuticals, wellness, health, livestock farming and water quality control). An important – and expanding – application of carrageenan is as an alternative to bovine or porcine gelatine for use by populations that adhere to a vegetarian, vegan and/or halal (or kosher) diet for religious and/or health reasons.

The industry as a whole – as in the case of the market for seaweed for human consumption – can therefore be expected to continue expanding. While technical collaboration with foreign companies results in what is usually termed a ‘win-win’ situation for two or several parties, it makes more sense for producing countries to learn from established players and invest in their own domestic processing technologies and facilities for the manufacture and export of products such as refined carrageenan. Where there are close ties between domestic research institutions and the industry, the likelihood is high that new, useful products might be an outcome (e.g. bioactive ingredients to alleviate disease). An important factor is to ensure market acceptability for these products while simultaneously making it profitable for seaweed culturists in order to maintain adequate supplies.

5.4 GLOBAL IMPORT-EXPORT TRADE IN SEAWEED AND SEAWEED PRODUCTS

The main regions in the global seaweed market are Asia and the Pacific, Europe, Latin America and North America, with the first (largely reflecting China, Japan and Indonesia) being the fastest growing in terms of volume and value. In the conventional developed markets of Japan, Europe (Western) and the United States of America, demand appears to have plateaued, perhaps due to the fact that all known applications are exploited almost fully.

Further growth prospects are considered to be very slow, with the exception perhaps of seaweed extract use as a replacement for the animal-based gelatine market, given the health concerns about bovine spongiform encephalopathy, religious dietary observances and the growing number of vegetarians. Elderly people also tend to use more processed foods in their diet and, as this population increases, so will the consumption of seaweed extract, in general, increase. Taking these factors into account, demand may expand, albeit at a lesser rate in developed countries, where the market is split more or less 50:50 between extracts in dairy and meat products.

In areas such as Central and South America, Eastern Europe, the Middle East and South and Southeast Asia, growth is likely to be stronger. According to a survey, per capita consumption of carrageenan in these regions may increase by 30–50 percent over the next decade due to improved market penetration. Allowing for population growth and assuming moderate economic expansion, a rise in carrageenan consumption by 5–7 percent per annum is probable. At present, the market is divided into approximately 20 percent dairy and 80 percent meat in terms of carrageenan application; this, however, is likely to change with a gradual increase in the dairy-food group.

For agar agar, usage is primarily for food purposes, such as in the preparation of jellies and sweet candies. This form of agar agar usually comes in strips and in powder form. The strips need to be soaked in water prior to use to facilitate the dissolving process, while the powdered form can be immediately dissolved. Consumer demand for agar agar powder, particularly from households in Asia and in the Middle East, has the potential to expand in parallel to the rising incomes of the middle class. Meanwhile, the growing range of hydrocolloids applications in the pharmaceutical and toiletry industries must be taken into account in terms of the future production of processed seaweed.

In conclusion, while the growth of the global seaweed market in the last two decades has been nothing short of impressive in terms of production and trade figures, what is equally important is the fact that seaweed harvesting, farming and simple processing sustains the livelihoods of millions of people in coastal communities throughout the world. As a result of the activities surrounding the industry, children in these communities have been able to access education, women now have the opportunity to empower themselves and families are better able to pay for their food and medical expenses. There may be no greater measure of success in the seaweed industry, to date or into the future.

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ANNEXES

World wild seaweed output, by species, weight in tonnes, 2006-2015											
Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Aquatic plants nei	288 062	364 437	403 642	303 031	274 445	306 643	287 570	314 189	274 093	285 056	
Brown seaweeds	198 239	163 726	184 611	186 505	185 127	179 994	171 587	185 946	186 704	175 642	
Red seaweeds	78 177	59 645	55 956	74 530	63 471	43 948	42 876	70 487	120 402	119 986	
Chilean kelp	161 834	136 766	202 262	222 628	190 746	241 633	268 722	313 341	219 998	115 311	
[Lessonia trabeculata]	27 552	31 010	33 754	54 120	62 734	46 239	48 040	38 724	60 531	72 071	
Japanese kelp	84 677	72 795	73 246	80 469	74 232	61 429	73 107	56 948	66 766	71 610	
Gracilaria seaweeds	44 153	69 739	63 967	1 169	45 089	42 224	24 340	46 053	32 352	45 344	
North Atlantic rockweed	61 390	51 736	52 508	53 763	56 332	47 374	50 588	51 371	48 991	44 203	
Leister	17 135	12 297	14 941	34 289	30 194	29 559	36 758	34 153	34 693	41 077	
Giant kelps nei	12 377	10 960	20 814	18 340	15 370	22 387	28 285	33 914	29 169	31 959	
Skottsberg's gigartina	33 331	41 879	41 896	29 159	19 725	14 616	26 336	40 756	27 068	27 327	
Tangle	15 991	28 949	28 191	20 714	23 774	42 299	15 998	53 590	28 052	12 509	
Green seaweeds	20 650	19 700	18 750	17 850	16 875	15 935	15 035	14 135	12 289	12 171	
North European kelp	2 891	8 114	8 114	2 806	2 677	9 481	5 309	21 384	37 314	10 489	
Bull kelp	2 292	4 274	4 872	5 872	6 048	6 468	2 649	8 304	8 509	9 441	
Wakame	7 144	6 384	3 114	3882	4 783	2 742	2 184	2 848	3 547	4 188	
[Mazzaella laminarioides]	3 731	5 108	4 372	4 225	1 172	2 096	1 574	3 181	4 607	3 013	
Gelidium seaweeds	1 618	1 337	1 290	1 395	1 148	1 241	1 267	1 367	2 892	2 707	
Seaweeds nei	176	8 855	8 885	18	-	3 236	27 368	1 366	701	2 533	
[Chondracanthus chamissoi]	1 590	980	1 031	2 001	914	998	1 400	2 475	2 715	2 199	
Others	4 544	6 212	3 808	3 175	1 052	2 456	2 275	1 904	2 111	2 986	
Total	1 063 010	1 098 691	1 226 216	1 116 766	1 074 856	1 120 542	1 130 993	1 294 532	1 201 393	1 088 836	

Source: FAO.

World wild seaweed output, by country, weight in tonnes, 2006–2015											
Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Chile	301 115	313 551	384 563	368 032	368 580	403 496	436 035	517 929	417 331	345 704	
China	270 410	328 600	366 100	276 170	246 620	274 060	257 640	283 010	245 550	261 770	
Norway	145 429	134 671	154 215	160 361	158 516	152 382	140 998	154 150	154 230	147 391	
Japan	113 665	103 602	104 668	104 103	97 231	87 779	98 514	84 498	91 601	93 300	
Indonesia	4 996	4 643	2 917	3 030	2 697	5 479	7 641	17 136	70 514	78 230	
Ireland	29 500	29 500	29 500	29 500	29 500	29 500	29 500	29 500	29 500	29 500	
France	19 160	39 757	29 757	18 907	22 597	47 307	41 229	69 126	58 512	19 110	
India	32 500	31 000	29 500	28 000	26 500	25 000	23 500	22 000	18 890	18 650	
Iceland	20 964	21 867	22 559	22 563	21 014	15 737	18 079	17 168	18 427	16 830	
Peru	3 434	10 786	13 779	5 677	4 368	5 801	3 585	22 089	25 827	14 824	
Canada	43 191	19 382	17 715	43 300	43 431	14 824	13 833	14 842	14 360	11 573	
Mexico	4 532	5 093	4 900	5 152	1 128	5 072	5 725	10 122	8 484	11 331	
Korea, Republic of	13 754	18 189	13 866	10 843	13 043	14 787	10 123	8 566	9 687	7 826	
South Africa	9 776	11 507	10 788	10 748	11 821	10 901	16 234	12 583	13 211	7 131	
Russian Federation	11 614	8 342	10 242	5 828	5 917	6 639	6 597	5 341	7 070	6 662	
United States of America	6 362	2 272	6 951	8 207	9 027	9 614	9 382	11 388	8 373	6 469	
Morocco	14 870	12 373	9 037	10 368	7 405	5 797	5 150	6 138	2 688	5 284	
Spain	485	109	97	64	124	261	525	1 215	2 151	2 386	
Australia	15 504	2 223	1 923	1 923	1 923	1 923	1 923	1 923	1 923	1 923	
Portugal	765	495	198	351	498	461	801	839	782	1 574	
Others	5 528	6 941	6 749	6 814	3 968	6 178	6 254	6 873	4 393	4 354	
Total	1 062 026	1 097 962	1 223 275	1 113 127	1 071 940	1 116 820	1 127 014	1 289 563	1 199 111	1 087 468	

Source: FAO.

World cultured seaweed production, by species, weight in tonnes, 2006-2015												
Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015		
Eucheuma seaweeds nei	1 159 422	1 582 286	2 016 230	2 870 448	3 481 401	4 615 764	5 852 837	8 430 343	9 033 651	10 189 939		
Japanese kelp	4 497 518	4 613 060	4 765 213	4 930 705	5 146 883	5 257 201	5 682 078	5 941 658	7 699 383	8 026 782		
Gracilaria seaweeds	1 054 024	1 272 509	1 386 547	1 526 393	1 691 028	2 171 031	2 762 556	3 460 203	3 751 396	3 880 748		
Wakame	2 027 763	1 765 619	1 756 197	1 694 540	1 537 339	1 754 504	2 139 477	2 079 099	2 359 413	2 296 468		
Elkhorn sea moss	1 452 632	1 495 118	1 674 739	1 772 669	1 888 392	1 956 576	1 962 952	1 726 016	1 710 631	1 753 686		
Nori nei	822 100	904 170	814 660	1 074 750	1 072 350	1 027 450	1 123 290	1 139 000	1 141 710	1 158 750		
Seaweeds nei	2 334 424	2 290 534	2 452 424	2 489 230	3 121 938	2 886 482	2 812 530	2 859 389	443 568	769 781		
Laver (Nori)	585 242	606 741	562 783	554 064	564 234	608 791	691 425	721 778	673 992	686 784		
Spiny eucheuma	154 622	187 587	216 424	220 555	258 652	266 122	287 975	233 048	240 817	273 600		
Fusiform sargassum	114 230	136 260	87 480	79 490	78 210	111 310	112 260	151 520	175 430	189 050		
Spirulina nei	55 870	66 920	62 320	70 890	96 942	73 048	80 266	82 025	85 705	89 441		
Brown seaweeds	21 943	21 209	18 961	21 272	22 747	27 701	16 962	15 819	19 149	30 450		
Green laver	682	684	8 003	5 903	4 531	6 085	6 002	5 034	6 055	6 748		
Fragile codium	165	158	1 186	1 796	1 394	1 005	855	2 045	5 550	3 895		
Aquatic plants nei	1 776	1 102	3 597	4 647	4 144	2 183	2 741	4 729	5 023	3 823		
Caulerpa seaweeds	5 444	5 177	4 288	3 881	4 309	5 145	3 928	3 029	1 199	1 219		
Bright green nori	10 160	10 550	12 540	10 600	11 150	9 100	8 900	4 390	1 000	1 000		
Warty gracilaria	5 944	9 382	6 861	4 383	4 888	4 865	3 478	3 210	936	634		
[Haematococcus pluvialis]	1 544	107	116	188	162	205	215	241	226	200		
[Spirulina platensis]	50	50	70	70	70	100	100	121	100	84		
Others nei	6 221	3 771	7 563	1 512	1 520	523	4 575	55	9	77		
Total, including other countries	14 311 776	149 72 993	15 858 203	17 337 986	18 992 284	20 785 191	23 555 401	26 862 752	27 354 942	29 363 158		

Source: FAO.

World cultured seaweed production, by country, weight in tonnes, 2006-2015											
Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
China	9 744 210	9 745 025	9 933 885	10 495 905	11 092 270	11 549 555	12 832 060	13 561 445	13 326 315	13 924 535	
Indonesia	1 170 000	1 728 475	2 145 061	2 963 556	3 915 017	5 170 201	6 514 854	9 298 474	10 076 992	11 269 341	
Philippines	1 468 905	1 505 070	1 666 556	1 739 995	1 801 272	1 840 833	1 751 071	1 558 378	1 549 576	1 566 361	
Korea, Republic of	765 595	792 953	921 024	858 659	901 672	992 283	1022 326	1 131 305	1 087 048	1 197 129	
Korea, Dem. People's Rep	444 300	444 300	444 300	444 300	444 300	444 300	444 300	444 300	48 900	48 900	
Japan	490 062	513 964	456 337	456 426	432 796	349 737	440 754	418 365	373 908	399 300	
Malaysia	60 000	90 269	111 298	138 857	207 892	239 450	331 490	269 431	245 332	260 760	
Zanzibar	76 760	84 850	107 925	102 682	125 157	130 400	150 876	110 438	133 020	172 490	
Madagascar	5 300	3 650	3 650	3 600	4 000	1 699	1 400	3 575	6 970	15 377	
Solomon Islands	1 354	866	1 159	4 029	7 104	7 218	6 990	11 812	12 162	12 200	
Chile	38 219	26 387	27 703	88 193	12 179	14 694	4 126	12 512	12 836	11 952	
Viet Nam	15 000	15 000	15 000	15 000	18 221	14 019	18 544	13 561	14 327	11 822	
Tanzania, United Rep. of	3 200	4 000	5 000	5 520	6 885	6 601	6 510	6 689	6 705	6 750	
Sri Lanka	-	-	-	-	-	1	23	25	9	4 760	
Papua New Guinea	-	-	-	-	100	250	1 400	2 500	3 000	4 000	
Kiribati	8 837	1 112	1 083	1 788	4 745	4 290	8 280	2 250	3 580	3 600	
India	1 954	2 522	4 706	6 922	4 242	4 502	4 502	4 502	3 002	3 002	
Myanmar	-	-	288	1 200	2 094	2 336	3 200	1 600	2 100	2 324	
Russian Federation	818	300	260	739	614	821	1 584	642	2 386	2 036	
South Africa	3 000	3 000	1 834	1 900	2 015	2 000	2 000	2 000	2 000	2 000	
Others	142 612	11 250	11 134	8 716	9 709	10 001	9 111	8 947	4 674	44 189	
Total	14 311 776	14 972 993	15 858 203	17 337 986	18 992 284	20 785 191	23 555 401	26 862 752	27 354 942	293 631 583	

Source: FAO.

World cultured seaweed production, by country, value in USD thousands, 2006–2015											
Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
China	2 082 169	2 067 950	2 311 139	2 357 839	2 533 196	2 502 025	2 852 190	3 040 904	2 307 646	2 420 653	
Indonesia	210 600	392 980	300 309	811 822	1 268 367	1 143 653	1 347 538	1 742 233	1 653 108	842 852	
Japan	939 490	957 384	972 037	1 081 155	1 143 130	994 352	1 397 119	933 056	863 568	807 300	
Korea, Republic of	269 657	332 524	311 305	252 112	327 823	344 276	391 705	411 137	496 496	440 575	
Philippines	173 963	136 850	291 039	201 154	256 715	263 110	231 735	233 618	256 293	182 779	
Korea, Dem. People's Rep	244 365	244 365	66 645	66 645	66 645	66 645	66 645	66 645	73 350	73 350	
Malaysia	2 454	3 940	6 686	7 884	17 444	21 919	23 616	25 672	63 752	33 577	
Chile	61 660	43 307	46 731	114 678	15 841	25 118	9 512	27702	33 104	29 282	
Sri Lanka	-	-	-	-	-	1	9	10	3	3 505	
Madagascar	716	493	493	486	540	143	109	275	1 446	2 636	
Russian Federation	982	360	312	887	737	985	1 901	770	2 863	2 443	
Zanzibar	740	580	1 265	1 327	1 781	1 668	1 915	1 399	1 657	1 789	
Viet Nam	2 438	2 422	2 393	2 285	2 545	1 880	2 448	1 782	1 863	1 484	
Spain	678	951	1 009	943	746	989	900	1 004	909	790	
Solomon Islands	21	18	54	204	403	305	434	709	760	709	
Greece	-	-	-	-	-	1 517	971	548	678	621	
South Africa	1 265	1 208	756	807	744	747	659	561	498	426	
Burkina Faso	220	220	308	280	280	400	400	480	400	320	
Papua New Guinea	0	0	0	0	4	13	81	134	183	217	
Tanzania, United Rep. of	31	27	65	168	196	168	165	180	203	205	
Others	2 716	8 570	2 436	6 588	5 303	3 609	3 111	1 902	1 745	1 378	
Total	3 994 165	4 194 149	4 314 982	4 907 266	5 642 440	5 373 521	6 333 161	6 490 720	5 760 527	4 846 891	

Source: FAO.

World cultured seaweed production, by species, value in USD thousands, 2006-2015												
Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015		
Wakame	768 997	693 952	757 677	758 326	650 949	722 080	996 739	914 126	1 063 847	1 005 760		
Gracilaria seaweeds	342 551	374 502	395 464	503 293	521 677	600 050	757 306	959 828	1 024 185	985 069		
Laver (Nori)	929 974	986 165	926 395	997 397	1 139 060	1 048 385	1 384 333	993 050	982 643	930 284		
Eucheuma seaweeds nei	225 507	392 799	302 974	823 551	1 134 714	1 065 061	1 268 536	1 644 886	1 535 030	782 556		
Japanese kelp	428 935	459 293	307 474	274 905	276 428	269 492	304 056	314 907	357 449	354 387		
Seaweeds nei	966 099	958 189	1 142 391	1 159 345	1 451 258	1 179 606	1 156 738	1 173 132	208 347	326 251		
Elkhorn sea moss	171 269	136 547	292 944	204 002	266 151	274 742	2 44 666	252 186	312 525	212 352		
Fusiform sargassum	45 692	55 867	40 241	36 565	35 977	51 203	51 640	69 699	80 698	86 963		
Nori nei	49 326	54 250	46 915	62 929	63 363	63 618	71 181	73 540	74 338	74 457		
Spirulina nei	22 348	37 475	37 392	35 445	48 476	37 942	41 017	41 520	43 500	45 297		
Brown seaweeds	15 155	14 424	15 605	17 280	19 179	21 851	17 373	8 549	43 673	16 271		
Spiny eucheuma	4 424	3 422	4 484	5 235	8 379	7 444	10 315	7 020	9 572	9 611		
Aquatic plants nei	4 454	4 867	13 795	9 967	9 931	12 233	12 093	21 471	11 066	8 915		
Green laver	1 172	897	6 639	4 141	3 691	4 467	3 822	4 509	4 828	5 428		
Caulerpa seaweeds	2 242	2 202	2 396	2 193	2 562	5 477	3 783	3 074	1 290	1 075		
Fragile codium	227	182	1 814	2 016	1 798	558	631	1 604	2 062	882		
[Haematococcus pluvialis]	3 088	214	232	376	324	738	2 183	4 767	4 299	400		
Bright green nori	4 572	4 642	6 145	4 240	4 460	3 640	3 560	1 756	400	400		
[Spirulina platensis]	220	220	308	280	280	400	400	496	400	361		
Green seaweeds	-	-	-	-	-	-	-	-	-	197		
Others	7 913	14 040	13 697	5 780	3 782	4 534	2 790	600	176	93		
Total	3 994 165	4 194 149	4 314 982	4 907 266	5 642 440	5 373 521	6 333 161	6490720	5 760 527	4 846 891		

Source: FAO.

China: Cultured seaweed production, by species, weight in tonnes, 2006-2015		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ASFIS species											
Japanese kelp		3 809 960	3877 355	3988755	4139825	4418010	4541105	4895030	5088 685	6 805 175	7 056 445
Gracilaria seaweeds		888 840	994 510	1144460	1253520	1147220	1513590	1967780	2461 120	2 622 320	2 701 490
Wakame		1 646 300	1402 270	1320210	1324170	1091330	1341750	1751210	1701 110	2 030 990	1 925 020
Nori nei		822100	904 170	814660	1074750	1072350	1027450	1123290	1139 000	1 141 710	1 158 750
Seaweeds nei		2 309 570	2265 050	2434920	2475410	3111480	2870430	2793340	2840 970	421 100	753 280
Fusiform sargassum		114 230	136 260	87480	79490	78210	111310	112260	151 520	175 430	
Spirulina nei		55 870	66 920	62320	70890	96910	72820	80050	81 890	85 530	89 250
Eucheuma seaweeds nei		84 080	86 840	67240	65900	64260	61800	95880	92 560	42860	50 050
Bright green nori		10 160	10 550	12540	10600	11150	9100	8900	4390	1 000	1 000
[Haematococcus pluvialis]		100	100	100	150	150	200	200	200	200	200
Japanese isinglass		3 000	1 000	1200	1200	1200	-	4120	-	-	-
Total		9 744 210	9 745 025	9 933 885	10 495 905	11 092 270	11 549 555	12 832 060	13 561 445	13 326 315	13 924 535

Source: FAO.

China: Exports of seaweed and other algae fit for human consumption, weight in tonnes; value USD thousands, 2012–2016									
Products	2012		2013		2014		2015		2016
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Value
Edible seaweed	21 595	132 007	14 185	70 794	12 545	66 847	11 654	53 739	56 179
Non-edible seaweed	1 007	1 352	1 214	983	1 383	1 317	1 153	2 948	1 896
Agar-agar	4 146	58 803	4 488	69 065	5 465	97 184	5 472	91 558	86 024
Carrageenan	42 491	293 323	44 397	356 549	48 742	397 032	52 549	375 782	360 134
Total	69 239	485 485	64 284	497 391	68 135	562 380	70 828	524 027	504 233

Source: China Customs.

China: Exports of seaweed and other algae not fit for human consumption, by destination, weight in tonnes, 2012–2016							
Destination	2012	2013	2014	2015	2016		
Viet Nam	183	286	296	387	411		
Korea , Republic of	126	205	435	413	380		
United States of America	9	0	1	42	272		
Malaysia	132	78	63	63	252		
Japan	155	263	229	103	62		
New Zealand	-	-	-	16	29		
Taiwan, Province of China	152	211	169	46	20		
Total, including other countries	1 007	1 214	1 383	1 153	1 477		

Source: China Customs.

China: Exports of agar agar (HS 130231), by destination, weight in tonnes, 2012–2016						
Destination	2012	2013	2014	2015	2016	
Italy	480	722	850	549	775	
Spain	84	146	353	425	663	
Malaysia	350	670	665	614	612	
Thailand	585	524	603	613	598	
Russian Federation	443	191	399	667	569	
Germany	458	546	667	618	521	
United States of America	104	99	194	212	285	
India	228	260	241	247	253	
Japan	129	95	156	277	244	
Korea, Republic of.	81	157	186	166	181	
Chile	127	243	280	211	160	
Taiwan, Province of China	107	122	92	130	145	
Brazil	88	82	88	116	84	
Ukraine	87	93	57	72	83	
Indonesia	452	106	48	59	50	
Morocco	20	20	15	15	75	
Argentina	16	42	93	37	59	
Singapore	36	52	59	48	53	
France	2	1	2	36	45	
Islamic Republic of Iran	50	43	64	58	44	
United Kingdom	28	52	38	12	38	
Lithuania	1	2	9	11	36	
Bangladesh	18	24	16	41	35	
Total Weight (tonnes)	4 146	4 488	5 465	5 472	5 846	
Total Value (USD millions)	58 803	69 064	97 184	91 558	86 024	

Source: China Customs.

China: Exports of carrageenan (HS 130239), weight in tonnes, 2012-2016						
HS Code	Product Type	2012	2013	2014	2015	2016
13023912	Algin	24 851	24 733	25 731	27 022	28 553
13023911	Carrageenan	9 422	11 365	13 164	16 251	18 591
13023990	Other mucilages and thickeners of vegetable product	4 635	4 643	5 805	5 695	5 993
13023919	Mucilages and thickeners of seaweeds and algae, Nes	3 583	3 656	4 041	3 581	3 500
130239	Total carrageenan	42 491	44 397	48 742	52 549	56 637

Source: China Customs.

China: Exports of carrageenan (HS 130239), value in USD thousands, 2012-2016						
HS Code	Product Type	2012	2013	2014	2015	2016
13023912	Algin	151 614	183 579	188 074	179 972	182 166
13023911	Carrageenan	71 626	95 104	117 691	116 400	101 198
13023990	Other mucilages and thickeners of vegetable product	55 396	56 874	66 236	57 458	56 803
13023919	Mucilages and thickeners of seaweeds and algae, Nes	14 686	20 992	25 031	21 953	19 967
130239	Total carrageenan	293 323	356 549	397 032	375 782	360 134

Source: China Customs.

China: Imports of seaweed fit for human consumption (HS 121221), by origin, weight in tonnes, 2012–2016						
Origin	2012	2013	2014	2015	2016	
Indonesia	62 283	105 231	126 950	126 573	137 450	
Korea, Republic of.	958	663	1 442	527	3 266	
Philippines	3 485	4 210	952	1 339	2 662	
Malaysia	161	752	504	1 464	1 279	
Chile	1 043	51	354	489	921	
Japan	169	156	166	137	139	
Tanzania, United Republic of.	240	292	225	538	120	
Papua New Guinea	-	105	113	258	79	
Taiwan, Province of China	80	34	3	12	44	
Russian Federation	-	-	-	-	30	
Total, including other countries			131 001	131 423	146 028	

Source: China Customs.

China: Imports of seaweed and other algae not fit for human consumption (HS 121229), by origin, weight in tonnes, 2012–2016						
Origin	2012	2013	2014	2015	2016	
Chile	45 529	63 785	51 400	45 554	59 008	
Peru	29 881	27 761	31 994	23 696	22 596	
Indonesia	58 936	43 492	24 011	24 226	15 477	
Philippines	13 145	27 408	9 204	2 990	2 574	
Korea, Republic of.	47	1 028	838	493	1 169	
South Africa	775	1 000	934	616	962	
Russian Federation	-	-	27	669	809	
Taiwan, Province of China	234	21	0	0	454	
Norway	-	-	0	20	92	
Argentina	33	37	70	0	45	
Total, including other countries	151 209	168 464	122 277	98 908	103 222	

Source: China Customs.

China: Imports of agar-agar (HS 1302), by origin, weight in tonnes, 2012–2016						
Origin	2012	2013	2014	2015	2016	
Italy	174	300	332	27	314	
Korea ,Republic of .	15	17	15	26	27	
Morocco	-	-	3	19	23	
Spain	13	15	14	15	14	
Germany	6	5	9	14	14	
Indonesia	-	-	2	9	11	
Taiwan, Province of China	2	2	2	5	7	
Japan	4	5	7	5	6	
Total, including other countries	227	348	392	124	418	

Source: China Customs.

Indonesia: Exports of seaweed and other algae fit for human consumption (HS 121221), by destination, weight in tonnes; value in USD thousands, 2012-2016										
Destination	2012		2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
China	63 799	39 205	83 491	68 830	88 915	99 168	119 887	93 952	86 035	59 254
Chile	5 076	4 620	5 202	6 426	6 122	9 912	7 226	8 545	4 858	4 544
Philippines	6 327	6 928	3 835	5 434	5 173	7 581	5 051	5 024	2 386	1 680
Korea, Republic of .	1 348	1 311	1 166	1 318	2 864	3 686	6 614	5 951	1 390	975
China, Hong Kong, Special Admin. Region	1 114	383	1 422	814	3 293	2 052	3 054	2 155	1 310	963
Viet Nam	4 173	3 583	1 504	939	4 295	2 745	5 783	3 863	1 178	451
France	360	243	1 040	1 144	1 239	1 308	1 774	1 754	837	363
Denmark	678	539	1 416	1 557	257	265	624	436	676	321
Canada	0	0	0	0	1 438	1 526	1 906	1 420	441	186
Japan	642	381	382	220	341	364	744	688	406	679
Spain	286	1356	365	1 001	1 002	2 539	1 486	1 160	381	123
Taiwan , Province of China	244	301	191	193	235	177	346	193	321	133
Argentina	870	693	550	516	726	952	675	672	193	139
Tunisia	665	585	100	85	396	251	410	175	119	42
United States of America	537	770	368	433	1 702	2 120	196	196	118	53
Morocco	0	0	0	0	0	0	15	11	100	74
Singapore	0	0	25	7	0	0	0	0	57	21
India	0	0	37	19	0	0	18	36	55	90
Malaysia	402	507	307	354	304	377	185	203	43	63
Germany	0	0	0	0	0	0	0	0	41	14
Thailand	28	25	0	0	55	65	135	119	28	23
Total, including other countries	86 817	62 631	101 547	89 904	118 759	136 450	156 390	127 361	100 972	70 195

Sources: Statistics Indonesia.

Annex 10b

Indonesia: Exports of carrageenan, weight in tonnes, 2012-2016							
HS Codes	Product Type	2012	2013	2014	2015	2016	
1302391010	Carageenan In Powder Form	3 707	4 057	4 164	4 138	4 565	
1302399000	Mucilages & Thickeners, Whether Or Not Modified, Der	826	542	120	242	521	
1302391090	Carageenan Not In Powder Form	732	700	648	810	417	
1302391000	Carageenan, Other	0	0	0	0	0	
130239	Total carrageenan	5 266	5 299	4 933	5 190	5 503	

Source: Statistics Indonesia.

Annex 10c

Indonesia: Exports of carrageenan, value in USD thousands, 2012-2016							
HS Codes	Product Type	2012	2013	2014	2015	2016	
1302391010	Carageenan In Powder Form	27 026	30 540	34 504	29 655	26 794	
1302391090	Carageenan Not In Powder Form	3 879	3 448	3 995	5 469	2 093	
1302399000	Mucilages & Thickeners, whether or not modified, Der	886	672	349	715	811	
1302391000	Carageenan, Other	0	0	0	0	0	
130239	Total carrageenan	31 791	34 660	38 848	35 840	296 989	

Source: Statistics Indonesia.

Annex 11a

Philippines: Exports of seaweed and other algae, fresh or dried, whether or not ground (HS 121220), by destination, weight in tonnes; value in USD thousands, 2012-2016		2012			2013			2014			2015			2016		
Destination		Weight	Value		Weight	Value		Weight	Value		Weight	Value		Weight	Value	
China		14 444	5 669		23 959	4 580		7 398	15 829		3 529	2 052		7 136	4 450	
United States of America		4 607	4 462		6 709	7 400		5 622	9 362		3 888	4 944		2 033	1 247	
France		1 740	1 400		806	727		1 505	1 246		3 033	1 307		1 276	759	
China, Hong Kong, Special Administrative Region (SAR)		77	280		125	435		86	237		49	50		129	89	
Spain		1 953	8 877		2 431	13 171		1 823	11 452		1 145	6 805		102	481	
United Kingdom		0	0		0	0		0	0		0	0		101	477	
Denmark		18	12		0	0		0	0		0	0		66	218	
Korea, Republic of.		488	618		1 150	718		224	606		2 314	1 618		62	273	
Argentina		120	213		0	0		0	0		20	18		50	258	
Brazil		82	500		376	2 383		302	2 636		200	1 786		31	134	
Taiwan, Province of China		77	84		70	240		46	76		78	84		23	26	
Viet Nam		381	281		174	137		384	153		94	53		20	21	
Israel		0	0		0	0		0	0		20	37		15	42	
Indonesia		132	1 369		2	15		2	16		1	8		5	16	
Japan		19	26		365	564		49	399		0	0		2	38	
Lebanon		1	1		1	2		1	1		1	1		1	1	
Malaysia		20	205		57	41		1	9		2	16		0	0	
New Zealand		25	88		74	127		10	94		13	100		0	0	
India		0	0		0	1		10	90		13	132		0	0	
Total, including other countries		26 053	31 319		37 063	34 356		18 493	49 300		14 910	21 739		11 052	8 539	

Source: Philippines Statistics Authority.

Annex 11b

Philippines: Exports of carrageenan (HS 130239), weight in tonnes, 2012–2016						
HS Codes	Product Type	2012	2013	2014	2015	2016
1302391019	Other Refined	20 673	14 586	15 871	19 169	31 002
1302391009	Other Semi- Refined	1 597	1 525	369	286	486
1302391001	Semi-Refined, Food Grade	10	4 040	9 489	7 195	204
1302391011	Refined Blended With Other Gums, etc.	4	7	16	0	61
1302399000	Other	1 750	3 345	889	531	60
130239	Total carrageenan	24 035	23 503	26 633	27 181	31 813

Source: Philippines Statistics Authority.

Annex 11c

Philippines: Exports of carrageenan (HS 130239), value in USD thousands, 2012–2016						
HS Codes	Product Type	2012	2013	2014	2015	2016
1302391019	Other Refined	130 130	133 647	126 512	137 350	185 883
1302391009	Other Semi- Refined	12 640	8 364	2 643	1 187	2 243
1302391001	Semi-Refined, Food Grade	90	28 949	77 353	41 924	1 348
1302391011	Refined Blended With Other Gums, etc.	30	69	134	0	295
1302399000	Other	9 937	24 214	6 596	5 000	402
130239	Total carrageenan	152 827	195 242	213 239	185 461	190 172

Source: Philippines Statistics Authority.

Chile: Exports of seaweed, weight in tonnes; value in USD thousands, 2012–2016										
Products	2012		2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Edible seaweed	5 616	10 942	5 619	12 949	3 522	8 663	1 107	4 162	748	4 617
Non- edible Seaweed	65 582	85 349	76 192	129 424	71 152	134 188	67 052	96 563	75 170	103 281
Agar-agar	1 925	43 804	1 771	44 070	1 780	48 754	1 825	48 790	1 562	39 030
Carrageenan	4 867	58 183	4 827	70 781	4 811	72 475	5 254	73 548	5 002	59 622
Total	77 990	19 8278	88 409	257 224	81 265	264 080	75 238	223 063	82 482	206 550

Source: National Customs Service (Servicio Nacional de Aduana).

World: Exports of seaweed and other algae fit for human consumption (HS 121221), weight in tonnes; value in USD thousands, 2012-2016										
Country	2012		2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Indonesia	86 817	62 631	101 547	89 904	118 759	136 450	156 390	127 361	100 972	70 195
Korea, Republic of .	27 193	157 018	26 323	135 047	22 408	135 941	22 908	144 350	31 719	188 384
China	21 595	132 007	14 185	70 794	12 545	66 847	11 654	53 739	14 721	56 179
Japan	35 043	19 247	28 150	17 110	25 701	16 468	9 827	14 702	14 620	17 333
Malaysia	0	0	550	921	687	1 326	2 261	1 871	2 224	1 764
United Kingdom	958	4 524	1 030	5 077	1 107	6 183	1 359	6 039	1 496	8 082
South Africa	269	670	290	649	1 050	1 357	731	1 064	1 299	1 690
United States of America	1 054	12 548	1 342	15 335	1 393	15 673	1 254	14 439	1 132	12 021
Japan	992	19 247	1 209	17 110	1 136	16 468	1 169	14 702	1 061	17 333
France	910	3 486	914	4 202	824	4 534	974	4 352	991	3 966
Chile	5 616	10 943	5 619	12 949	3 522	8 663	1 107	4 162	748	4 617
Germany	366	2 860	725	5 362	502	4 064	671	4 633	710	3 636
Ireland	579	781	481	718	1 190	613	687	329	433	368
Thailand	135	2 523	441	5 039	414	4 157	622	4 331	428	3 494
Taiwan, Province of China	0	0	14	303	253	5 138	236	4 318	410	5 038
Denmark	609	4 738	549	4 575	364	3 332	364	2 853	361	2 880
Netherlands	420	7 733	336	9 688	319	8 395	192	3 608	292	4 991
Spain	308	2 695	236	2 311	202	3 438	455	3 877	238	2 571
Belgium	126	994	108	941	168	1 610	113	1 402	171	1 648
Poland	2	43	2	15	1	4	3	23	166	509
Austria	49	320	73	648	94	818	170	1 214	163	1 451
Russian Federation	77	733	133	1 312	124	1 336	116	1 252	143	1 542
Norway	162	287	6	79	10	173	10	189	114	406
Total of top 23 countries and territories	183 280	446 028	184 263	400 089	192 773	442 988	213 273	414 810	174 612	410 098

Source: National Statistics.

World: Exports of seaweed and other algae not fit for human consumption (HS 121229), weight in tonnes; value in USD thousands, 2012–2016											
Country	2012		2013		2014		2015		2016		Value
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value	
Indonesia	81 463	71 524	74 564	72 552	81 947	89 778	49 915	33 048	81 399	53 812	
Chile	65 582	85 349	76 192	129 424	71 151	134 188	67 052	96 563	75 170	103 281	
Ireland	31 829	15 944	37 754	21 327	42 153	23 026	49 313	22 773	44 722	24 580	
Peru	27 120	23 374	30 440	35 710	29 008	32 889	24 385	17 875	21 687	16 058	
Iceland	1 815	1 559	4 439	3 795	4 255	4 188	3 083	3 309	4 959	6 998	
France	1 408	8 035	1 824	8 914	1 622	7 372	2 293	3 787	4 448	6 193	
Norway	562	1 256	633	1 451	892	2 032	2 255	2 721	3 525	4 026	
Morocco	-	-	-	-	0	0	2 425	8 676	2 507	10 410	
Portugal	339	717	929	2 116	152	722	899	2 204	1 635	3 631	
China	1 007	1 352	1 214	984	1 383	1 317	1 153	2 949	1 477	1 896	
Russian Federation	0	0	0	10	46	36	770	65	1 031	66	
Spain	428	919	740	1 978	887	2 717	1 171	2 934	946	3 029	
Australia	1 180	1 589	836	1 143	959	1 340	552	690	870	1 018	
Germany	88	677	248	2 293	250	950	233	841	706	1 437	
United Kingdom	486	1 566	414	1 605	843	2 021	923	1 989	481	115	
Mexico	133	173	295	405	503	709	419	619	396	656	
Netherlands	180	583	514	1 660	304	1 741	661	2 522	358	1 521	
Taiwan, Province of China	0	0	5	22	47	447	75	458	292	388	
United States of America	357	4 001	207	2 557	270	2 653	224	2 708	204	2 670	
Argentina	74	483	77	493	158	769	101	935	201	1 079	
Belgium	159	675	316	265	391	479	180	263	160	333	
Italy	26	64	20	64	41	162	76	180	158	410	
Japan	84	1 060	99	1 075	109	1 199	133	1 229	153	1 636	
South Africa	1 130	937	1 379	1 145	800	1 000	537	567	134	402	
Brazil	132	212	123	224	159	392	148	414	125	312	
India	0	0	157	3 032	227	4 507	295	5 526	121	2 406	
Thailand	195	552	189	406	189	349	123	343	114	296	
Total of top 27 countries and territories	215 777	222 601	233 608	294 651	238 746	316 982	209 394	216 188	247 979	248 658	

Source: National Statistics.

World: Exports of agar-agar (HS 130231), weight in tonnes; value USD thousands, 2012–2016											
Country	2012		2013		2014		2015		2016		Value
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value	
China	4 146	58 803	4 488	69 064	5 465	97 184	5 472	91 558	5 846	86 024	
Chile	1 925	43 804	1 771	44 070	1 780	48 754	1 825	48 790	1 562	39 030	
Spain	1 062	23 896	1 179	30 292	1 309	36 445	1 478	37 971	1 302	33 581	
Indonesia	1 292	12 861	1 056	13 084	933	14 812	750	9 932	946	8 908	
Morocco	932	23 677	1 066	28 225	925	25 485	905	24 117	936	26 258	
Germany	407	9 507	520	12 846	606	15 992	658	14 650	672	13 564	
Taiwan, Province of China	66	268	114	360	201	578	229	575	496	1 050	
Korea, Republic of .	380	12 152	478	13 143	465	12 727	416	10 809	429	12 039	
Thailand	135	1 091	95	987	55	1 015	189	1 289	199	1 507	
India	184	3 029	210	3 778	163	3 370	148	2 858	166	2 909	
France	152	5 196	188	6 589	170	4 100	114	3 243	138	4 462	
United States of America	213	6 218	270	8 787	197	8 294	170	6 991	134	4 506	
Mexico	45	1 181	60	1 573	78	2 168	99	2 826	101	2 755	
Belgium	44	1 757	62	2 484	116	3 841	186	3 308	100	2 859	
Singapore	58	992	79	1 578	76	1 720	58	1 316	76	1 294	
United Kingdom	92	1 638	125	2 238	83	2 122	57	1 629	68	2 019	
Belarus	-	-	-	-	0	12	7	31	51	36	
Netherlands	73	1 469	97	1 820	135	2 626	124	1 998	51	2 035	
Malaysia	52	242	13	225	11	133	126	226	42	195	
Lithuania	4	91	13	527	18	156	31	335	39	399	
Japan	29	1 364	32	1 317	27	1 193	21	983	36	1 576	
Total of top 21 countries and territories	13 303	209 236	13 929	242 987	14 827	282 727	15 078	265 435	15 406	247 006	

Source: National Statistics.

Annex 16a

World: Exports of carrageenan (HS 130239), top 35 exporters, weight in tonnes, 2012–2016					
Exporting countries	2012	2013	2014	2015	2016
China	42 491	44 397	48 742	52 549	56 637
Philippines	24 035	23 503	26 633	27 181	31 813
Germany	9 821	11 283	9 460	8 202	7 871
Netherlands	3 543	9 031	12 500	2 427	1 973
Spain	7 271	7 370	7 722	9 598	9 128
India	5 790	7 018	5962	2 408	1 019
USA	7 365	6 896	6 233	5 805	5 593
France	6 419	6 043	5 839	5 145	5 442
Indonesia	5 266	5 299	4 933	5 190	5 503
United Kingdom	5 984	5 056	4 612	4 907	5 591
Chile	4 867	4 827	4 811	5 254	5 002
Belgium	4 498	3 607	3 786	3 677	3 513
Canada	2 711	2 793	2 928	2 953	2 737
Korea Republic of.	2 156	2 671	2 345	2 514	2 280
Peru	3 341	2 367	2 264	2 408	2 487
Guatemala	1 390	1 484	1 313	1 308	1 330
Italy	1 632	1 333	1 615	1 364	2 165
Malaysia	741	754	1 018	798	573
Thailand	880	619	675	779	711
Romania	427	588	392	445	308
Switzerland	483	391	408	350	334
South Africa	236	325	120	99	65
Poland	196	224	313	1 089	3 047
Singapore	376	211	163	318	124
China, Hong Kong, Special Administrative Region	185	189	141	121	121
Austria	167	186	134	138	113
Greece	16	160	6	18	6
Islamic Republic of Iran	18	152	330	597	89
Argentina	128	144	357	132	332
Total of top 35 countries and territories	142 433	148 921	155 755	147 774	155 907

Source: National Statistics.

World: Exports of carrageenan (HS 130239), top 35 exporters, value in USD thousands, 2012–2016					
Leading Exporters	2012	2013	2014	2015	2016
China	293 323	356 549	397 032	375 782	360 134
Philippines	152 827	195 242	213 239	185 461	190 172
United States of America	91 867	83 374	80 459	75 345	70 996
France	74 925	80 161	83 008	68 036	68 209
Chile	58 184	70 781	72 475	73 458	59 622
Germany	59 707	67 273	65 553	54 530	49 215
Spain	54 488	62 709	71 489	75 628	68 571
Indonesia	31 791	34 660	38 848	35 840	29 698
Belgium	39 002	33 601	38 057	33 765	31 230
United Kingdom	36 330	29 534	25 981	26 055	27 897
Korea, Republic of .	23 270	28 370	26 872	25 345	21 771
Canada	18 427	18 299	18 466	18 908	16 456
Peru	23 177	16 882	13 652	12 176	9 941
Italy	13 908	14 528	12 996	9 965	10 188
Netherlands	9 925	14 161	14 494	15 927	12 249
India	12 586	13 788	11 959	8 414	3 400
Malaysia	3 618	5 239	6 463	4 804	2 694
Guatemala	3 859	4 130	3 531	3 448	3 602
Switzerland	3 959	3 497	3 763	2 445	2 159
Israel	2 586	3 274	2 661	2 230	570
Thailand	3 063	2 856	3 744	3 952	3 884
Singapore	4 893	2 760	2 298	1 933	1 507
Poland	2 054	2 509	3 411	2 606	2 981
South Africa	1 291	1 809	603	354	266
China, Hong Kong Special Administrative Region (SAR)	1 862	1 721	994	973	945
Austria	1 440	1 327	972	910	721
Estonia	1 186	1 311	1 350	1 063	855
Argentina	1 062	1 220	3 033	1 120	2 638
Japan	1 416	997	1 586	1 876	1 370
Total of top 35 countries and territories	1 026 025	1 152 560	1 218 989	1 122 348	1 053 939

Source: National Statistics.

World: Imports of seaweeds and other algae fit for human consumption (HS 121221), weight in tonnes; value in USD thousands, 2012–2016														
Country	2012			2013			2014			2015			2016	
	Weight	Value		Weight	Value		Weight	Value		Weight	Value		Weight	Value
China	68 812	77 271		113 147	135 635		131 001	180 190		131 423	125 436		146 028	118 544
Japan	36 910	211 155		30 776	177 688		31 427	179 062		30 182	164 276		32 989	210 207
Taiwan, Province of China	0	0		1 436	4 478		17 569	43 252		17 676	44 083		16 229	43 581
Korea, Republic of .	17 625	22 231		12 665	14 841		14 325	22 125		19 135	19 609		12 159	55 587
United States of America	7 789	51 028		6 370	61 497		7 180	60 670		10 695	72 678		8 560	55 883
United Kingdom	952	5 137		2 339	7 914		5 413	11 943		6 889	15 298		5 922	10 817
Thailand	2 121	15 417		2 759	25 901		3 408	36 334		3 837	40 690		4 554	56 450
Norway	7 693	9 196		6 318	7 691		6 402	9 710		7 688	13 506		4 125	7 074
France	16 055	27 760		13 068	25 880		11 013	26 443		3 246	9 376		3 482	9 557
Russian Federation	2 568	5 188		2 978	6 610		4 384	11 301		2 903	7 797		2 506	6 691
Australia	1 210	16 243		1 315	19 552		1 480	19 063		2 149	21 188		2 218	19 011
Chile	2 710	4 863		3 993	7 285		2 688	8 194		2 986	7 611		1 598	4 889
Germany	758	6 507		1 219	10524		1 104	5 046		1 371	4 743		1 374	5 713
Austria	694	1 956		1 037	3 477		904	3 120		1 026	3 237		1 068	3 977
China, Hong Kong SAR	754	2 748		825	3 806		1 114	4 789		2 018	8 326		1 068	5 161
Malaysia	0	0		496	4 190		651	4 546		880	6 204		914	11 430
Poland	404	835		323	1 163		544	1 459		612	1 780		733	2 802
Brazil	507	2 833		792	5 008		810	5 851		812	6 111		719	4 812
Spain	227	1 695		257	2 411		552	5 371		605	3 938		592	5 054
Italy	304	4 415		399	5 946		501	5 605		496	6 085		580	6 135
Singapore	349	4 886		270	4 241		344	4502		465	5 658		536	6 967
Ukraine	-	-		-	-		716	1 667		463	1 020		521	1 093
Belarus	479	2 002		743	3 339		723	2 963		678	2 517		517	1 682
New Zealand	495	3 947		740	4 066		377	4 468		323	3 779		383	5 840
India	0	0		217	5 505		209	9 616		177	10 778		355	5 111
Belgium	258	1 622		186	1 769		314	3 033		371	2 489		318	2 535
Netherlands	399	5 249		290	4 771		252	4 292		452	5 530		294	4 649
Mexico	171	2 487		215	3 347		243	4 203		282	4 720		279	4 683
Kazakhstan	311	474		340	495		270	413		319	423		187	258
Sweden	117	1 121		127	1 164		150	1 207		172	1 262		176	1 481
Denmark	145	1 767		117	2 207		191	1 963		184	1 632		175	1 758
Argentina	0	0		56	360		79	465		80	530		110	785
Total of top 32 countries and territories	17 0817	49 0033		20 5813	562 762		246 338	682 866		250 595	622 310		251 269	640 217

Source: National Statistics.

World: Imports of seaweed and other algac not fit for human consumption (HS 121229), weight in tonnes; value in USD thousands, 2012–2016												
Country	2012		2013		2014		2015		2016			
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value		
China	151 209	131 937	168 464	189 766	122 277	157 973	98 908	94 839	103 222	106 485		
Ireland	329	471	21 511	3 054	34 140	5 382	46 089	5 860	45 563	6 797		
United States of America	19 539	42 803	23 652	49 177	18 030	46 698	14 826	36 400	20 959	38 481		
France	1 123	2 962	1 133	2 442	8 769	11 738	17 877	25 258	17 437	18 772		
Japan	15 114	32 210	14 548	36 058	15 141	36 629	12 903	28 089	11 497	27 605		
Spain	5 936	16 093	6 200	17 823	6 295	21 664	8 527	17 560	9 952	16 452		
Australia	5 702	4 612	4 237	3 536	7 848	4 102	11 256	5 094	8 969	4 733		
Denmark	6 924	10 205	6 866	12 197	5 533	11 708	6 244	10 309	5 401	6 402		
Chile	4 382	3 751	3 454	3 817	5 815	7 982	6 968	7 096	5 248	4 493		
South Africa	3 147	1 397	2 832	1 315	3 253	1 522	3 383	1 386	3 366	1 479		
United Kingdom	874	3 488	23 845	4 805	4 797	6 435	4 850	3 349	3 237	5 468		
Italy	1 009	2 166	1450	2 511	1 684	3 721	1 783	3 239	2 062	3 505		
Portugal	563	1 733	768	3 356	155	776	16	60	1 277	2 326		
Germany	2 604	3 442	1 109	3 234	635	2 440	770	2 078	1 154	2 993		
Korea , Republic of	551	703	397	1 274	737	1 855	944	2 137	1 049	2 018		
Argentina	1 055	1 389	769	867	942	1 260	1 069	2 334	917	2 501		
Poland	730	783	984	994	1 036	1 083	938	629	846	560		
Taiwan, Province of China	0	0	39	486	978	3 146	1 002	1 243	652	1 233		
Turkey	-	251	-	257	667	736	792	664	605	550		
Singapore	77	365	66	126	313	180	545	498	517	498		
Brazil	1 459	4 333	225	1 278	346	3 328	783	6 203	516	3 656		
Netherlands	422	1 888	627	2 062	1 000	3 248	896	2 710	443	2 087		
Malaysia	0	0	478	2 859	455	2 970	241	1 216	381	1 445		
New Zealand	518	754	218	743	188	691	229	645	313	614		
Mexico	76	443	90	646	178	648	206	746	264	908		
Russian Federation	126	388	267	648	258	1 003	157	564	260	1 007		
Hungary	165	112	228	292	442	1 564	381	1 369	258	942		
Cyprus	86	95	102	83	104	95	108	107	182	182		
Morocco	-	-	-	-	0	0	648	822	180	174		
China, Hong Kong SAR	77	67	194	213	131	230	144	263	177	229		
Greece	162	1 535	129	1 225	112	1 936	144	1 724	135	2 109		
Belgium	231	1 672	170	1 180	209	1 451	113	522	132	753		
Czech Republic	133	159	192	196	154	145	128	112	126	99		
Colombia	9	70	6	59	70	70	98	139	118	119		
Uruguay	0	-	44	-	214	153	111	77	101	67		
Total	224 332	272 279	285 294	348 578	242 906	344 563	244 077	265 340	247 516	267 741		

Source: National Statistics.

World: Imports of agar agar (HS 130231), weight in tonnes, value in USD thousands, 2012-2016										
Country	2012		2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Japan	1 706	45 536	1 785	46 519	1 850	49 873	1 955	49 803	1 813	45 447
United States of America	1 428	28 914	1 420	31 597	1 417	34 379	1 565	38 499	1 383	31 949
Germany	618	12 318	696	13 715	867	18 981	952	18 541	969	18 173
Spain	451	7 038	1 905	12 769	753	15 713	883	14 653	956	15 275
United Kingdom	193	6 914	580	9 930	357	11 256	488	7 695	864	11 241
Russian Federation	263	4 229	273	4 794	577	11 756	906	17 989	732	12 530
Thailand	724	9 300	695	10 102	818	11 260	812	11 801	731	11 580
Malaysia	765	7 509	869	6 889	680	6 527	531	5 799	532	6 271
France	1 107	9 978	370	9 234	393	9 715	397	10 120	440	11 680
China	227	5 602	348	8 473	392	10 105	124	3 573	418	7 730
India	318	5 531	375	6 949	316	6 613	298	5 890	353	6 038
Canada	196	2 111	196	2 620	164	2 863	215	2 639	336	2 714
Poland	222	4 085	231	4 768	238	5 484	237	4 819	253	4 528
Korea, Republic of	99	1 730	167	3 035	197	3 786	175	3 202	203	3 294
Ukraine	160	2 751	184	3 040	136	2 702	166	3 275	197	3 266
Chile	125	2 391	264	4 791	311	6 382	255	4 968	177	3 131
Taiwan, Province of China	136	1 469	153	1 592	124	1 513	158	1 828	172	2 053
Morocco	82	1 460	106	1 826	105	2 200	82	1 734	171	2 604
Mexico	126	2 423	117	2 427	113	2 712	125	2 812	165	3 895
Belgium	70	2 047	93	2 781	161	4 585	239	4 046	145	3 495
Denmark	126	3 277	106	3 288	88	2 784	95	2 644	119	3 351
Venezuela	478	654	432	777	148	285	36	32	115	105
Ireland	-	198	-	607	5	302	20	593	106	6 807
Uruguay	18	360	19	407	210	493	1	492	100	332
Singapore	125	1 353	107	1 784	119	1 752	108	1 580	99	1 206
Total of top 25 countries and territories	11 775	169 178	13 504	194 714	12 553	22 4021	12 838	219 027	13 565	21 8695

Source: National Statistics.

Annex 20a

World: Imports of carrageenan (HS 130239), top 35 countries, weight in tonnes, 2012–2016					
Importers	2012	2013	2014	2015	2016
Germany	18 219	23 229	19 710	11 204	10 486
United States of America	12 062	10 152	11 475	11 192	9 959
Spain	4 183	4 512	4 908	6 578	8 321
United Kingdom	4 921	5 122	5 381	6 521	6 227
Mexico	5 596	5 555	5 693	6 367	6 671
Belgium	7 741	6 719	5 551	6 331	5 469
France	5 475	6 629	6 802	6 325	7 683
Denmark	4 647	5 198	4 714	5 601	5 009
Russian Federation	2 888	2 795	3 441	4 507	4 457
Netherlands	3 738	6 026	4 197	4 103	4 336
China	3 039	3 757	4 289	3 969	3 015
Japan	3 233	3 412	3 462	3 665	3 419
Poland	3 982	3 626	3 577	3 630	3 553
Brazil	2 252	2 861	2 681	3 509	2 352
Canada	3 039	3 875	2 639	3 323	2 534
Italy	5 234	5 170	4 746	3 252	5 156
Thailand	2 549	2 629	2 918	2 940	3 517
Turkey	2 394	2 599	2 571	2 143	2 288
Ireland	1 671	3 549	1 989	2 034	1 812
Argentina	1 971	1 669	1 923	2 015	1 281
Philippines	1 302	1 333	1 676	1 934	2 309
Indonesia	1 725	1 735	2 055	1 588	2 035
Australia	1 677	1 640	1 682	1 577	1 540
Austria	1 335	2 333	1 727	1 577	1 463
Korea, Republic of.	1 132	1 518	1 465	1 543	1 305
Chile	953	904	728	1 203	1 602
Venezuela	800	1 595	1 436	1 106	705
Ukraine	1 417	1 245	1 034	1 096	1 074
Malaysia	1 035	1 140	997	1 019	977
Total of top 29 countries and territories	110 210	122 527	115 467	111 852	110 555

Source: National Statistics.

Annex 20b

World: Imports of carrageenan (HS 130239), top 35 countries, value in USD thousands, 2012–2016					
Countries	2012	2013	2014	2015	2016
United States of America	100 328	97 118	114 695	105 699	82 830
Germany	101 734	115 124	118 577	84 254	69 808
Denmark	52 262	57 970	59 974	62 750	48 361
Mexico	49 750	47 692	50 894	57 209	52 698
Spain	38 282	41 773	49 510	54 174	52 359
Belgium	57 935	49 397	46 216	51 414	42 198
United Kingdom	32 225	37 336	37 514	42 055	35 370
France	34 974	36 648	42 695	41 638	36 753
Russian Federation	23 943	24 535	29 760	34 968	32 447
Japan	32 543	27 505	31 185	30 421	29 490
China	22 313	23 939	29 121	26 881	23 016
Italy	40 567	28 681	27 766	26 499	18 506
Netherlands	18 413	24 260	20 070	25 344	25 654
Brazil	18 855	24 700	23 414	24 896	17 264
Poland	31 387	29 420	29 575	24 275	20 271
Canada	22 545	29 948	22 582	23 961	19 038
Philippines	14 442	15 026	17 891	21 346	15 904
Thailand	21 645	24 090	22 475	21 113	23 954
Sweden	4 378	10 673	11 085	16 901	11 087
Argentina	17 482	13 898	16 196	16 674	10 665
Indonesia	18 094	20 875	24 099	16 376	20 231
Australia	12 635	12 232	13 629	12 542	11 940
Korea , Republic of .	6 575	11 798	12 764	11 951	9 734
Chile	9 406	9 075	7 914	11 891	10 592
Venezuela	6 875	13 328	14 350	10 476	5 416
India	8 539	8 382	11 053	9 277	10 466
Ukraine	14 052	12 040	9 837	8 972	7 311
Austria	8 821	10 225	10 416	8 946	7 940
Malaysia	7 727	9 220	8 228	8 872	8 544
Total of top 29 countries	828 724	866 905	913 486	891 776	759 845

Source: National Statistics.

United States of America: Imports of seaweed and other algae fit for human consumption (HS 121221), by origin, weight in tonnes; value in USD thousands, 2012–2016															
Origin	2012			2013			2014			2015			2016		
	Weight	Value		Weight	Value		Weight	Value		Weight	Value		Weight	Value	
Iceland	1	83 006		1	68 702		138	250 384		962	1 290 479		2 543	2 973 967	
China	2 059	22 308 909		2 500	30 870 557		2165	24 588 057		2 002	25 718 326		1 815	19 572 496	
Canada	2 531	4 486 142		517	2 106 298		692	3 853 016		1 378	5 822 974		1 555	7 788 308	
Korea, Republic of	784	8 005 581		823	9 551 954		881	10 039 991		1 034	11 990 293		1 144	11 963 898	
Philippines	649	4 153 140		1 382	7 539 148		1086	6741416		1 388	5 448 660		591	3 217 668	
United Kingdom	190	667736		294	1 109 699		180	908 628		468	2 408 076		432	2 547 624	
Japan	266	5 685 515		325	5 656 127		246	4 471 988		268	4 589 120		211	5 095 437	
Chile	26	1 029 227		21	756 342		69	1 291 059		1 405	5 830 584		103	1 264 425	
Taiwan, Province of China	120	586 607		145	710 788		114	478 621		45	214 913		41	179 374	
India	38	634 280		6	86 823		88	1 746 276		137	2 685 870		26	551 490	
China, Hong Kong SAR	17	130 649		12	48 867		52	138 256		14	61 897		23	110 849	
Viet Nam	15	22 202		33	47 065		108	166 978		189	281 285		20	55 692	
Mongolia	0	0		0	0		0	0		0	0		16	115 240	
Mexico	272	397 179		39	77 573		106	194 300		110	179 596		10	54 971	
Thailand	4	121 758		3	137 935		11	217 551		9	273 775		8	161 022	
Denmark	208	1 267 130		214	1 289 940		37	252 300		53	500 610		8	58 782	
Peru	1	2 304		6	25 333		51	95 019		94	174 338		7	23 901	
Australia	0	8 284		0	0		1	65 281		1	42 740		5	86 500	
Argentina	0	7 905		0	0		1	6 900		2	13 800		2	19 300	
Finland	0	0		0	0		0	0		0	0		0	23 547	
Germany	1	6 422		1	80 000		0	0		2	40 500		0	3 511	
Netherlands	6	80 753		2	109 410		1	61 409		1	31 391		0	14 991	
Tanzania, United Republic of.	0	0		0	0		133	1 412 764		125	1 639 050		0	0	
Tonga	0	0		0	0		0	0		0	2 262		0	0	
Morocco	191	302 779		0	0		153	316 047		57	130 530		0	0	
Russia	0	21 105		0	25 004		0	22 000		0	0		0	0	
Spain	0	0		0	0		0	5 721		0	9 173		0	0	
Switzerland	0	0		0	0		0	0		0	2 919		0	0	
Madagascar	379	320 690		0	0		80	78 982		60	69 984		0	0	
Indonesia	0	0		0	0		772	2 700 791		880	2 778 035		0	0	
Ireland	0	0		0	0		0	2 768		1	12 800		0	0	
France	32	698 939		44	1 166 911		17	563 633		13	434 303		0	0	
Total, including other countries	7 789	51 028 242		6 370	61 497 265		7 180	60 670 146		10 695	72 628 283		8560	55 882 996	

Sources: US Dept.of Commerce, Bureau of Census.

United States of America: Imports of seaweed and other algae not fit for human consumption (HS 121229), weight in tonnes; value in USD thousands, 2012-2016												
Origin	2012		2013		2014		2015		2016			
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value		
Indonesia	2 659	2 178 388	1 688	1 517 758	1 537	1 605 422	2 218	1 569 866	5 378	2 558 549		
Canada	3 322	5 808 425	5 069	8 758 795	5 331	8 938 900	4 853	8 428 814	4 094	8 097 883		
Tanzania, United Republic of.	3 731	3 438 066	5 439	3 065 684	3 602	1 975 262	1 495	914 830	3 675	1 947 876		
Philippines	4 129	4 929 564	4 051	7 227 385	1 962	6 516 453	3 047	8 336 892	3 120	6 897 124		
Chile	2 233	8 025 496	2 498	11 821 334	2 362	12 800 757	0	42 880	1 231	4 461 116		
Norway	165	1 272 405	259	1 663 026	317	2 066 696	415	1 851 742	867	2 757 309		
China	493	4 027 056	307	1 421 615	277	1 471 451	622	2 941 867	687	2 703 839		
Mexico	233	291 400	634	794 584	240	310 815	224	314 186	298	398 648		
Ireland	191	632 914	131	720 141	166	795 384	158	865 163	269	396 714		
Viet Nam	221	247 450	245	287 385	123	214 375	221	277 464	265	258 411		
Madagascar	40	36 811	640	390 024	260	192 651	0	0	260	131 769		
United Kingdom	154	871 192	216	1 145 219	220	1 431 687	201	1 186 561	172	868 085		
Korea , Republic of .	729	4 371 110	495	1 897 682	520	2 058 994	516	2 079 683	139	657 878		
Taiwan, Province of China	166	930 023	115	746 896	94	596 452	135	783 010	135	956 228		
Peru	145	209 662	72	116 640	48	74 571	72	125 686	119	208 514		
Morocco	38	60 116	328	524 381	96	198 720	397	828 743	98	202 239		
India	134	2 479 370	178	3 197 640	95	1 856 850	115	2 176 410	77	1 532 640		
China, Hong Kong SAR	0	98 422	0	21 540	2	16 660	53	112 740	22	45 669		
Japan	30	872 129	15	197 415	10	157 980	36	213 009	14	147 675		
Thailand	10	213 299	5	25 355	2	7 540	0	2 073	12	414 321		
Germany	0	148 949	0	33 000	0	0	11	41 096	9	45 773		
Netherlands	0	42 255	0	51 608	5	31 688	0	6 945	6	39 703		
Israel	0	32 500	0	1 263 596	5	1 748 500	7	2 401 600	6	2 013 115		
Australia	2	123 634	20	111 936	2	169 657	3	434 834	5	672 291		
Argentina	0	0	0	4 708	1	63 677	6	44 180	2	13 765		
Total, including other countries	19 539	42 802 898	23 652	49 176 840	18 030	46 697 855	14 826	36 399 578	20 959	38 481 444		

Sources: US Dept.of Commerce, Bureau of Census.

Annex 21c

United States of America: Imports of agar-agar (HS 130231), weight in tonnes, 2012–2016					
Origin	2012	2013	2014	2015	2016
Spain	266	295	321	411	334
Chile	372	257	263	297	261
China	99	123	206	313	259
Morocco	229	267	209	199	184
Korea, Republic of	6	94	102	79	104
Thailand	93	52	62	55	59
Mexico	29	39	51	47	52
Taiwan, Province of China	59	58	53	45	44
Italy	18	19	25	23	41
United Kingdom	0	0	0	0	12
Philippines	13	10	15	14	8
Viet Nam	8	0	1	4	6
Japan	5	4	8	5	5
China, Hong Kong SAR	8	9	8	8	4
Denmark	2	1	0	2	3
New Zealand	9	6	0	3	3
Singapore	0	0	0	0	1
Indonesia	149	146	71	40	1
India	44	2	1	1	1
France	0	0	0	0	0
Norway	0	0	0	0	0
Netherlands	0	1	0	0	0
Total, including other countries	1 428	1 420	1 417	1 565	1 383

Sources: US Dept. of Commerce, Bureau of Census.

Annex 21d

United States of America: Imports of carrageenan (HS 130239), weight in tonnes, 2012–2016					
Origin	2012	2013	2014	2015	2016
Philippines	6 326	4 805	5 152	5 653	4 958
Chile	966	1 174	1 208	1 033	980
Indonesia	570	606	696	655	711
Canada	422	539	531	572	587
France	626	549	540	478	464
Spain	340	439	401	404	447
China	462	465	703	498	375
Korea , Republic of .	181	261	257	233	353
Denmark	155	158	207	174	152
United Kingdom	154	64	128	144	127
Ireland	12	9	11	21	37
Malaysia	15	0	122	107	28
India	0	0	0	0	16
Total, including other countries	10 245	9 105	9 965	9 981	9 236

Sources: US Dept. of Commerce, Bureau of Census.

Japan: Imports of seaweed and other algae fit for human consumption (HS 121221), weight in tonnes; value in USD thousands, 2012-2016										
Origin	2012		2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
China	24 434	120 233	23 382	111 954	22 275	103 471	22 604	91 709	24 967	113 657
Korea, Republic of.	11 935	86 863	7 074	62 041	8 812	72 318	7 077	68 545	7 763	93 608
Brazil	99	205	135	278	127	304	118	301	110	280
Chile	69	1 934	81	2 427	62	1 739	116	2 462	60	1863
Viet Nam	32	420	42	507	85	605	196	679	47	494
Argentina	10	40	26	138	16	63	20	79	20	82
Russian Federation	69	458	27	122	22	120	11	27	11	50
France	1	7	0	0	1	4	1	11	5	21
China, Hong Kong SAR	0	0	0	0	0	0	0	0	4	26
Taiwan, Province of China	32	517	6	107	15	269	18	316	2	33
India	0	0	0	0	0	0	2	47	1	12
Ireland	0	0	0	0	0	7	0	0	0	21
United States of America	1	119	1	103	1	96	1	61	0	34
Sweden	0	0	0	0	0	0	0	0	0	24
Spain	0	0	0	0	0	0	0	0	0	2
Philippines	5	20	0	3	0	2	0	4	0	0
Thailand	0	0	0	0	12	53	0	0	0	0
Tonga	210	315	0	0	0	0	18	32	0	0
Australia	0	0	0	2	0	11	0	0	0	0
Canada	0	0	1	5	0	0	0	2	0	0
Total, including other countries	36 900	211 155	30 670	177 688	31 450	179 062	30 900	164 276	32 990	210 207

Source: Japan Ministry of Finance.

Annex 22a-2

Japan: Imports of seaweed and other algae fit for human consumption (HS 121221), by species, weight in tonnes; value in USD thousands, 2012–2016											
HS Codes	Species	2012		2013		2014		2015		2016	
		Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
121221100 THS	Seaweeds & Other Algae, FIT for Human Consumption	480 332	31 032	436 345	25 754	540 157	30 844	436 211	21 462	652 268	39 837
121221329	Wakame (Undaria Pinnatifida), FIT for Human Consumption	13 221	21 662	9 942	15 080	11 015	15 937	9 786	12 346	12 761	18 855
121221321	Wakame (Undaria Pinnatifida), FIT for Human Consumption	9 607	79 897	9 552	74 619	9 139	71 435	8 814	64 180	9 073	76 509
121221310	Hijiki (Hizikia Fusiforme), FIT for Human Consumption	4 564	39 178	4 267	35 187	4 255	36 582	4 479	39 634	4 861	46 606
121221322	Wakame (Undaria Pinnatifida), FIT for Human Consumption	4 778	8 783	4 021	6 730	4 467	6 941	4 007	5 890	3 182	7 108
121221390	Other Seaweeds & Other Algae, FIT for Human Consumption	4 667	29 625	2 927	19 730	2 436	16 214	2 939	19 385	2 911	19 439
121221200	Seaweeds & Other Algae, FIT for Human Consumption	74	978	67	589	115	1 110	158	1 380	201	1 854
121221	Seaweeds & Other Algae, FIT for Human Consumption	na	211 155	na	177 688	na	179 062	na	164 276	na	210 207

Source: Japan Customs.

Japan: Imports of seaweed and other algae not fit for human consumption (HS 121229), by origin, weight in tonnes; value in USD thousands, 2012–2016										
Origin	2012		2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Chile	8 521	10 323	6 823	10 500	7 655	13 976	5 518	6 810	4 156	5 210
Norway	198	248	210	335	364	957	812	976	2 018	1 986
Indonesia	1 039	1 272	772	973	1 265	1 481	1 664	1 798	1 508	1 783
Morocco	850	3 524	851	3 266	635	2 388	694	2 743	1 151	5 154
Ireland	1 220	1 236	1 360	1 446	1 498	1 631	1 720	1 605	1 011	980
Korea, Republic of:	1 072	7 374	1 660	10 389	903	5 690	839	5 738	715	5 265
Canada	1 102	5 781	1 830	7 083	1 650	7 995	902	6 603	229	5 251
China	445	1 070	358	795	317	980	254	498	222	290
South Africa	182	422	191	410	154	300	230	378	199	451
Spain	0	0	0	0	0	0	48	136	164	541
Senegal	45	261	38	220	7	41	0	0	32	222
Mexico	36	106	48	145	89	276	108	340	31	96
Brazil	0	0	0	0	0	0	30	187	30	155
Malaysia	2	10	2	17	8	57	10	62	16	119
Sri Lanka	8	10	44	51	0	0	0	0	9	8
Viet Nam	0	0	0	0	10	19	0	5	3	26
Philippines	305	194	258	177	11	29	6	44	2	11
France	19	199	10	114	9	114	2	36	0	12
Israel	0	0	0	0	0	0	0	0	0	39
United States of America	0	8	0	2	0	13	0	0	0	2
Thailand	0	0	0	0	0	0	0	0	0	3
Turkey	0	0	0	0	0	0	29	43	0	0
Ukraine	0	0	0	0	0	0	0	3	0	0
Switzerland	0	0	0	0	0	0	0	6	0	0
Taiwan, Province of China	1	25	1	9	5	42	3	27	0	0
Iceland	0	0	48	52	552	626	24	28	0	0
Australia	1	3	1	2	1	2	2	4	0	0
Egypt	10	19	5	10	7	14	8	17	0	0
Total, including other countries	15 114	32 210	14 548	36 058	15 141	36 629	12 903	28 089	11 497	27 605

Sources: Japan Ministry of Finance.

Japan: Imports of agar-agar (HS 130231), by origin, weight in tonnes; value in USD thousands, 2012–2016										
Origin	2012		2013		2014		2015		2016	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Chile	877	21 392	857	22 199	922	25 597	947	25 419	860	21 214
Korea, Republic of .	321	11 068	355	10 096	339	9 736	293	8 009	278	8 762
Morocco	171	5 510	265	7 357	218	5 993	242	6 242	240	7 087
China	130	2 489	93	1 783	144	2 976	282	5 581	238	4 151
Indonesia	134	2 574	117	2 101	182	3 952	122	2 488	156	2 642
Spain	12	340	11	346	10	304	52	1 446	39	1 396
United States of America	0	85	0	195	2	97	1	79	1	76
Mexico	0	46	0	0	1	50	2	109	1	56
United Kingdom	0	40	0	27	0	25	0	28	1	62
Viet Nam	0	0	0	0	0	5	0	0	0	0
Portugal	56	1 940	59	1 907	30	1 030	9	256	0	0
Italy	2	51	3	83	3	104	5	145	0	0
Germany	0	0	0	0	0	3	0	0	0	0
Total, including other countries	1 702	45 536	1 785	46 519	1 850	49 873	1 955	49 803	1 813	45 447

Source: Japan Ministry of Finance.

Annex 22d-1

Japan: Imports of carrageenan (HS 130239), by origin, weight in tonnes, 2012–2016					
Origin	2012	2013	2014	2015	2016
Thailand	902	946	1 034	1 122	1 056
Philippines	300	335	557	554	477
India	536	685	473	478	354
Indonesia	237	197	213	287	328
Denmark	269	272	274	292	290
Korea, Republic of.	268	260	234	269	220
Peru	163	208	150	192	182
United States of America	268	246	263	189	181
France	205	185	156	132	133
Spain	12	8	42	58	124
China	11	10	21	40	28
Switzerland	12	10	19	20	18
Chile	9	12	10	13	15
Italy	37	38	16	19	14
Total, including other countries	3 233	3 412	3 462	3 665	3 419

Source: Japan Ministry of Finance.

Annex 22d-2

Japan: Imports of carrageenan (HS 130239), by origin, value in USD thousands, 2012–2016					
Origin	2012	2013	2014	2015	2016
Denmark	6 444	5 393	5 484	5 285	6 247
Philippines	4 022	4 056	7 204	6 904	5 751
United States of America	6 985	5 142	5 515	4 084	4 434
Indonesia	3 573	2 525	2 881	3 750	3 721
Korea, Republic of.	4 345	3 509	3 520	3 693	2 978
France	3 454	2 821	2 559	2 142	1 826
Spain	322	232	749	802	1 429
Peru	1 264	1 745	1 170	1 323	1 046
Thailand	780	729	769	750	786
India	680	716	645	712	441
China	167	154	256	449	347
Chile	208	226	173	271	272
Switzerland	129	109	196	185	153
Italy	117	120	51	54	49
Total, including other countries	32 543	27 505	31 185	30 421	29 490

Source: Japan Ministry of Finance.

Annex 23a

European Union (Member Organization): Imports of seaweed and other algae fit for human consumption (HS 121221), value in USD thousands, 2012–2016					
EU Importers	2012	2013	2014	2015	2016
France	27 763 154	25 894 571	26 503 645	9 418 614	9 593 275
Germany	6 496 309	10 516 537	5 026 151	5 060 414	5 712 664
United Kingdom	5 127 273	7 893 205	12 536 313	15 649 753	11 063 558
Italy	4 414 736	5 946 233	5 605 016	6 084 607	6 135 337
Netherlands	5 249 378	4 771 251	4 292 228	5 572 915	4 888 185
Austria	1 955 813	3 476 894	3 120 315	3 213 609	3 977 272
Spain	1 694 752	2 410 943	5 370 966	3 938 116	5 026 766
Denmark	1 767 371	2 207 093	1 962 891	1 632 288	1 759 901
Ireland	3 420 696	1 831 834	326 096	316 941	198 035
Belgium	1 621 542	1 768 939	3 032 944	2 489 172	2 534 891
Sweden	1 121 118	1 164 027	1 207 476	1 262 014	1 480 835
Poland	831 927	1 161 263	1 453 515	1 693 216	2 656 844
Hungary	993 677	954 942	116 518	49 042	72 326
Czech Rep.	594 750	600 321	608 233	861 056	643 979
Finland	407 461	570 176	655 761	606 839	756 935
Greece	406 306	463 591	918 542	420 193	226 790
Portugal	498 281	429 454	921 556	702 019	794 768
Latvia	356 916	372 693	360 717	316 556	336 877
Lithuania	362 687	360 705	442 144	322 646	340 226
Romania	471 937	329 136	310 179	319 859	392 895
Slovakia	203 480	224 863	160 232	114 361	193 730
Bulgaria	151 072	211 956	146 792	139 067	152 585
Estonia	163 733	188 014	176 006	100 722	62 343
Slovenia	99 497	177 755	197 807	134 144	68 661
Cyprus	164 129	123 101	92 542	78 007	206 924
Luxembourg	56 070	104 206	114 351	106 340	168 877
Serbia	40 487	96 119	30 247	9 889	27 816
Croatia	105 066	70 966	66 880	65 632	60 939
Malta	23 900	41 596	57 457	48 148	128 194
Total EU-28 imports	66 563 518	74 362 384	75 813 520	60 726 179	59 662 428

Source: EUROSTAT.

Annex 23b

European Union (Member Organization): Imports of seaweed and other algae not fit for human consumption (HS 121229), value in USD thousands, 2012–2016					
EU Importers	2012	2013	2014	2015	2016
Spain	16 072 860	17 823 415	21 664 255	17 560 585	14 585 290
Denmark	10 205 265	12 197 023	11 708 389	10 308 559	6 400 533
United Kingdom	3 467 322	4 804 009	6 695 674	5 492 262	6 139 272
Portugal	1 733 307	3 355 556	776 165	59 681	2 325 880
Germany	3 437 719	3 228 400	2 428 270	2 213 475	2 993 639
Ireland	471 206	3 054 306	5 381 890	5 859 699	6 796 640
Italy	2 166 086	2 510 635	3 720 625	3 238 694	3 505 074
France	2 964 341	2 443 823	11 740 222	25 263 598	18 777 123
Netherlands	1 887 710	2 061 522	3 248 213	2 709 763	2 087 165
Greece	1 534 672	1 225 338	1 935 736	1 724 055	2 109 315
Belgium	1 671 996	1 180 178	1 451 269	521 624	753 110
Poland	781 671	992 459	1 081 415	629 070	558 918
Sweden	229 218	373 736	361 063	1 916 005	731 774
Hungary	111 573	292 038	1 564 033	1 369 058	873 545
Finland	204 810	227 240	258 371	348 901	85 821
Bulgaria	11 056	202 747	50 385	10 763	7 255
Czech Rep.	159 067	195 694	144 570	112 430	97 984
Romania	6 175	188 261	201 531	182 194	53 188
Serbia	84 359	176 693	72 918	17 129	41 238
Cyprus	95 267	83 361	94 761	106 708	182 213
Lithuania	15 396	54 507	55 839	80 526	54 275
Austria	139 484	50 294	109 680	45 050	188 876
Slovakia	22 712	38 672	46 405	23 815	17 723
Latvia	15 552	27 113	28 535	29 324	45 620
Estonia	9 086	23 901	97 377	83 598	13 676
Slovenia	5 784	12 968	13 324	14 345	19 008
Malta	3 757	12 219	6 974	21 150	4 063
Luxembourg	1 248	3 302	5 988	6 514	27 567
Croatia	36 741	1 023	13 443	13 795	20 014
Total EU-28 imports	47 545 440	56 840 433	74 957 320	79 962 370	69 495 799

Source: EUROSTAT.

Annex 23c

European Union (Member Organization): Imports of carrageenan, value in USD thousands, 2012-2016					
Main Importers in EU-28	2012	2013	2014	2015	2016
Germany	101 733 502	115 123 886	118 576 825	84 254 169	69 808 285
Denmark	52 262 048	57 970 054	59 974 353	62 749 688	48 360 940
Spain	38 282 218	41 772 586	49 509 502	54 173 991	52 359 220
Belgium	57 934 831	49 397 418	46 216 187	51 413 523	42 197 525
United Kingdom	32 224 626	37 335 817	37 513 881	42 055 174	35 370 099
France	34 973 990	36 648 219	42 695 438	41 637 813	36 752 751
Italy	40 566 988	28 681 362	27 766 087	26 498 785	18 505 500
Netherlands	18 412 858	24 259 577	20 069 913	25 344 348	25 653 850
Poland	31 386 538	29 419 892	29 574 926	24 274 583	20 271 352
Sweden	4 378 036	10 672 829	11 084 633	16 901 373	11 086 744
Austria	8 820 716	10 224 784	10 416 138	8 945 781	7 939 677
Ireland	2 805 940	4 952 224	5 252 450	6 632 794	7 044 704
Czech Rep.	6 754 637	7 148 398	7 376 024	6 276 707	4 918 350
Romania	3 316 822	3 785 095	4 811 726	4 429 734	2 737 462
Slovakia	3 934 874	5 709 405	4 682 378	3 512 321	2 859 670
Greece	3 998 828	2 773 642	2 623 923	2 428 349	2 105 992
Portugal	1 986 709	2 397 751	1 796 012	1 957 595	1 780 945
Lithuania	2 052 400	2 115 881	2 117 972	1 942 291	2 468 904
Serbia	1 404 312	1 399 481	1 237 659	1 584 236	946 167
Belarus	2 138 600	3 158 900	2 396 600	1 498 100	1 927 100
Bulgaria	1 240 461	1 816 762	1 746 022	1 436 584	1 122 977
Croatia	1 149 894	1 413 341	1 499 921	1 169 875	1 452 786
Malta	763 885	1 357 629	1 180 586	1 004 452	480 421
Finland	951 587	958 962	945 172	853 206	792 888
Estonia	1 550 167	1 172 368	621 685	721 281	216 872
Latvia	565 048	1 001 473	800 095	517 937	471 422
Slovenia	690 404	429 158	378 469	363 815	451 319
Cyprus	241 744	142 405	148 886	96 615	152 275
Luxembourg	6 610	7 022	7 342	11 095	12 720
Total EU-28 imports	456 529 273	483 246 321	493 020 805	474 686 215	400 248 917

Source: EUROSTAT.

Annex 23d

European Union (Member Organization): Imports of agar-agar (HS 130231), value USD thousands, 2012–2016					
Main importers in EU-28	2012	2013	2014	2015	2016
Germany	12 317 974	13 714 638	18 980 996	18 540 611	18 173 425
Spain	7 037 599	12 769 434	15 712 573	14 653 308	15 275 287
United Kingdom	6 914 049	9 929 733	11 255 502	7 694 753	11 240 883
France	9 977 923	9 233 724	9 714 756	10 119 501	11 679 568
Poland	4 084 708	4 768 076	5 484 308	4 818 697	4 528 452
Denmark	3 277 436	3 288 408	2 783 591	2 643 793	3 350 644
Belgium	2 046 993	2 781 401	4 584 885	4 045 767	3 494 627
Austria	1 406 290	1 846 765	1 938 953	1 554 384	1 939 714
Netherlands	1 047 397	1 618 315	2 205 423	1 584 485	1 279 362
Serbia	1 274 736	1 459 849	1 811 537	1 293 661	1 595 830
Lithuania	514 377	911 028	789 072	907 928	1 090 865
Czech Rep.	423 464	761 412	2 238 774	716 925	677 612
Finland	222 574	628 864	292 229	252 698	263 843
Ireland	198 481	606 709	301 916	592 699	6 807 025
Portugal	196 302	352 532	290 792	291 287	241 182
Latvia	248 157	327 885	1 006 703	1 232 036	357 150
Croatia	337 591	313 895	540 165	528 700	510 097
Sweden	262 728	309 018	248 172	380 742	292 666
Greece	269 552	296 870	293 170	251 887	274 376
Hungary	211 521	190 534	195 665	197 830	196 473
Slovenia	78 824	159 816	95 516	87 354	92 513
Bulgaria	49 986	152 627	138 986	188 828	34 863
Slovakia	110 302	114 358	250 118	217 209	152 020
Romania	86 303	89 288	95 207	112 751	156 523
Luxembourg	16 467	17 487	22 705	19 092	16 778
Estonia	124 384	9 211	25 740	23 515	26 988
Cyprus	1 613	6 309	1 874	1 172	6 624
Malta	13 650	2 503	150	463	221
Total EU-28 imports	52 751 381	66 660 689	81 299 478	72 952 076	83 755 611

Source: EUROSTAT.

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